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The Present and Future of Electrical Power in the South.

The final expressions, when reviewing the electrical developments creditable to any twelve months during the past few years, have been appropriate to wonderful accomplishments and striking advancements. Every reviewer has, to the best of his ability, governed his enthusiasm by his best judgment, yet optimism for the future and expressions of appreciation for the general introduction of electricity into every detail of daily life making possible commercial developments as they are now seen in all sections of our country, has reigned supreme and rightly so. Nowhere, for the more recently active sections, has such action been more justifiable than for the South. Nowhere, we emphasize again, can the most conservative be truly optimistic on account of the remarkable advances and rapid strides in Southern electrical development. From the Potomac and Ohio Rivers on the North, to the Atlantic and the Gulf on the East and South, can be observed the reconstruction action, the immediate result of quiet electrical activities and the progressive methods of those agencies that are shaping the destiny of this broad land from the coast Westward.

In the midst of all this activity, as we now are, it is most difficult to seperate the really important factors and point out the features that are temporary in the development and thus give a true prospective of the general tendencies toward the real and stable things. Never has there been credited to any twelve months, the number and size of distinct electrical advances in the South that will fall to 1911. Further, never has there been an indication at the end of any twelve months previous to the last, pointing to developments of unestimably greater importance for the immediate future. With a past of this nature to consider and a vision of the future still larger to account for, the most optimistic of us must reflect, consider and ask when this state of affairs will reach an economical limit, or we must endeavor to imagine the nature of industrial activities and the routine of our daily lives when the mechanical and automatic has developed to its fullest. Surely in view of such rapid development and general progress and in this day of business built and layed out for future returns, we must refer to our future business destiny. In line with the above we find food for thought in the words of Mr. T. C. Martin, one of our foremost authorities on electrical progress, as follows: "Today with some two billion of dollars invested, the place of electric light and power in American social economy is so well established, that there is even a tendency to treat the industry as one of the 'sure things' whose return should be adjusted to a level of government bonds. Such an opinion is complimentary, to say the least, but it ignores the fact that the field is expanding more rapidly than ever before, that new capital must be invited more urgently than ever before, that while the basic principles are known, the apparatus itself is changing more swiftly than ever before, and that the demands for service are more varied and diversified and difficult to satisfy than ever before. It would seem to

follow that the rewards to enterprise, capacity and experience should be higher than ever before; but it is hardly likely that this will be promised until the public appreciates more fully than ever before what the central station means as a pre-eminent factor in providing for the comfort, convenience, economy and general enjoyment of life by the great masses of our population."

To attempt a review of the details of Southern electrical progress during the past year would be beyond the space available in SOUTHERN ELECTRICIAN, and in fact tax the capacity of a work of considerable volume. Through the columns of this issue, however, we are particularly fortunate to be able to give the next best substitute for a detailed review, namely, the important features of the past and the general tendencies toward the future from the view points of those electrical engineers who are closely associated with particular phases of Southern engineering and industrial progress. In the main, the distinct fields of development may be separated into electrical generation, electrical distribution, utilization of electrical energy and the electrical transmission of intelligence. In the field of electrical generation, the South is particularly fortunate through a provision of nature, in abundant and available water power.

The largest number of hydro-electric developments have been confined to the Piedmont region of the South, extending from the base of the Appalachian Mountains toward the ocean and Gulf, a few miles north and south to some 300 miles in North Carolina. Along the line known as the fall line, where the Piedmont Plain breaks over into the lower Coastal Plain, there are falls or rapids wherever there is a stream. While this line indicates roughly the location of a number of larger powers now developed, there has been recently large developments successfully engineered outside of this district through large dams creating flood and storage regulating reservoirs. From present indications there will be available for utilization during the next year over 300,000 H. P. generated from new developments of the latter design, and either entirely out of the Piedmont region or on the very outskirts. At the present time there is in the South about seven and one-half millions commercial horsepower in developed and undeveloped waterpower, with only approximately one and one-half per cent in actual use. The opportunity for hydro-electric development in the South, therefore, makes it naturally the leading type of recent installation.

The remarkable electrical progress of the South has not at any time suffered a serious retardation due to the fact that at the period when all the reconstructing agencies were launched, engineering science had reached a point that permitted rapid advancement. Were it not for the evolution of electrical transmission, Southern waterpower would be valueless except for power at the waterpower site. It could not be transmitted to light the streets of our cities, or do the work in our factories and mines. However, thanks to the initiative of the Southern Power Company, which has been the example for the past eight years, electrical transmission lines in the South extend to the borders of the section and economical power can now be purchased at will.

In the North, great manufacturing centers have been built up because of a plentiful supply of coal and iron, but the price of coal is gradually rising, and it is evident that the eventual manufacturing supremacy of any section of the country will be based on its water power resources and water transportation facilities in connection with the railroads instead of upon coal resources and steel rails alone.

Even at the present time, Southern electrical developments are not required to search for a market for electrical power. The market is already established, for besides the rapidly growing cities and towns demanding light and power, there are fast growing net works of electrical and interurban systems developing in the South at a tremendous rate. Further, there are over 850 textile mills in the South, representing over 350,000 horsepower, 75 per cent of which is yet to be converted. There are something like 1,000 cotton oil mills in the South, driven largely by steam power, but fast changing to electric. Next in importance to these two great classes of customers, showing active interest in electrification, is the phosphate and fertilizer factory, the iron and coal mine. When this market has been supplied, the disappearance of the available timber supplies suited for wood pulps will force the paper industry of New England to look Southward for a combination of cheap power and raw material suitable for paper manufacture, such as cotton and rice straw. Mr. George Westinghouse, in his address before the Southern Commercial Congress last March, referred to the future of electricity in the South and showed the possibility of utilizing Southern water powers in the treatment of ores, in the production of nitrogen, in modes of transportation, in the stimulation of the soil, the sterilization of food products, and purification of water.

Whether the future utilization of our electrical energy be in this particular direction or not, it is certain that our industries will naturally gravitate to the places of cheap power and raw materials, for the same reasons that water finds its own level. Surely the pendulum of manufacturing progress which has for so many years swung Northward, has now started in the opposite direction, or Southward. It, therefore, behooves everyone to realize the causes of this tendency in the pendulum's swing and watch carefully and protectively over the agencies that have and forever will attract growth and prosperity to the South.

Referring finally to the indication which most forcefully shows up the general receptiveness of Southern people as a whole to the wave of progress placing them back in a position of prominence held 50 years ago, we have only to show the general tendency and desire for intercommunication to keep abreast with the times. This is illustrated by the general demand for one of the world's greatest electrical blessings, the telephone. No less than 20,000 farmers' homes have been equipped with telephones during the past year, and something over three score of towns of from 300 to 500 people have installed telephone exchanges. Facilities of this nature point toward more economical conditions and general progress.

The beginning of the South, the opening of its great commercial and agricultural possibilities, must be credited to the invention of the cotton gin, however, the finishing touch of a century has been the transportation and utilization of electrical power. To place in type the prophesy of a second century through the interaction of complicated agencies in the district south of the Mason and Dixon line, would seem to readers of today an idle dream, especially in view of the fact that every twelve months brings results little thought of or little realized.

Notes on Electrical Progress of 1911 and Present Tendencies.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

PROF. HENRY H. NORRIS.

ELECTRICAL egineering is now so closely allied with all branches of industry and all public service that it is impossible to isolate it for the purpose of retrospective study. It is well, however, while looking forward to the expected development of 1912, to consider some of the conspicuous tendencies and accomplishments of the preceding year.

Very little in the way of sensational invention or discovery occurred in 1911. It was a commercial rather than a scientific year. Not that business was remarkably good but rather a great deal of attention was focused on the problem of educating the public to the intelligent and liberal use of electric energy. As the central station is an energy factory the same principles of skilled salesmanship must be applied to the disposal of its product as would be used in selling shoes or carpets. This fact seems to have been realized more actively in the past year than before, if one is to judge by the efforts made by central station managers to create a demand for their product. Electric energy can be produced cheaply only if it can be sold continuously, hence strenuous effort is being made to fill up the depression in the load curve by inducing customers to use energy out of peak-load hours. This tendency to look at power station operation from the selling as well as the producing standpoint is evidenced by the increasing use of elaborate advertising schemes, such as finely equipped and lighted demonstration salesrooms, house-to-house solicitation of business with offers of low prices in wiring and fixtures, free expert engineering advice on the applicability of electric service to customers' needs, and attractive schedules of rates calculated to stimulate large use of energy. The manufacturers as well as the public service companies are working along these lines because it is to their interest to induce people to use electric energy and thus force the development of central stations. The manufacturers profit both by sales to small customers and by the sale of new equipment to the power stations. This industrial condition during the past year is reflected in two significant facts. First, although the gross incomes of the manufacturing companies are not so much greater than usual, the numbers of sales are much larger. Second, there is an increasing demand for technically-trained young men who have the aptitude and the desire for sales work.

HENRY H. NORRIS, PROFESSOR OF ELECTRICAL ENGINEERING AND IN CHARGE OF ELECTRICAL DEPARTMENT AT CORNELL UNIVERSITY. MEMBER A. I. E. E.

While, as stated above, sensational discoveries have not been prominent during the past months it should not be inferred that science has been neglected. The reverse is true, for the need for the application of science to industry was never greater than now. Manufacturers realize that, to get efficient results, the latest scientific work must be utilized and expensive research laboratories are maintained for the purpose. The scientists in these laboratories are given facilities for research in pure as well as applied science. The recent extension of the range of telephone service both by aerial lines and by underground cables was possible only because it was based upon sound science. Of no little scientific and practical importance was the International Electrical Congress and the simultaneous meeting of the International Electrotechnical Commission at Turin in the late summer. The papers of the Congress were excellent and from the practical standpoint the decisions and recommendations of the Commission were such as to promote international friendliness. Hereafter *I* will represent current, *E*, electromotive force, and *R*, resistance, all over the world. Vector diagrams of alternating quantities will be so drawn that a vector in advance of another in a counter clock-wise direction will hereafter represent a quantity leading that represented by the other. The name "reactive power" will now be universally used to designate the product of an alternating current by an e. m. f. in quadrature with it. A number of symbols for electric and magnetic quantities were recommended and other matters of importance were agreed upon. American technical typography will have to be changed less than that of some foreign countries for most of the decisions of the Commission were in line with our custom. At the request of the Congress the Commission assumed control of future international electrical congresses. The first invitation for a Congress accepted by the Commission was one extended by the American Institute of Electrical Engineers, the Congress to be held at San Francisco in 1915 in connection with the Panama Pacific Exposition.

During the past year the relation of the public to pub-

lic service corporations has been given increasing prominence. These corporations are coming to be more and more completely controlled by state public service commissions and by the Interstate Commerce Commission. Occasionally there is a set-back to the growing importance of the commissions, as recently occurred in the State of New York, but on the whole their power is increasing. The public more directly also, through municipal regulation, is increasingly active in governing the companies which enjoy special privileges at their hands. This is a natural and correct tendency but it leads at times to injustice and exerts a depressive effect on securities held largely by the same public. Public service officials are frank to own the past existence of the abuses which now irritate the public mind. The people were exploited for the benefit of promotors and properties were financed on an inflated basis, the promoters pocketing the returns from the sale of the capitalized good-will of the public. All this is acknowledged but it is largely a thing of the past.

Two very active associations of a semi-scientific character which are wielding great influence in public service matters are the National Electric Light Association and the American Electric Railway Association. While these organizations are made up largely of public service companies and employees, they are endeavoring to emulate the example of the scientific and civic societies in fostering a proper public spirit. The growth of the National Electric Light Association in the past few years has been phenomenal and it is now, probably, the largest of all in point of numbers. The railway association has also grown remarkably. During the year both held large and enthusiastic conventions. The former is working to stimulate the central station managements both to generate electric energy efficiently and to promote its use more widely. It operates through company and geographical sections as well as through its central organization. The latter organization, through affiliated associations, is endeavoring to teach the electric railway managers to give better service at greater profit to themselves. The Association is particularly concerned at present with an increase in fare. There is a strong tendency on the part of commissions to insist upon the retention of the standard nickel fare, in spite of the increase in cost of labor, fuel and supplies. The commissions insist on longer rides, better cars, better service, but at the same fare. This, of course, cannot be continued much longer and when conditions are really understood the companies will be allowed to increase fares either directly or indirectly through a reduction in the number of accessory privileges now enjoyed.

In engineering work it is difficult to select from the mass of interesting detail the most significant items. The eye is attracted by the large operations although they may not be essentially the most important. In the traction field we note the extension of the 1,200-volt system with the consequent saving in sub-station cost. The use of the 1,200-volt motor has not spread as much as was expected, a conservative preference for standard, tried equipment being evident. The heavy terminal electrifications have demonstrated increasing reliability, the delays from electrical troubles being now insignificant. The largest heavy electrification undertaking was that of the New Haven Railroad involving the equipment of the Hoosac tunnel with the single-phase system, the construction of the New York, Westchester and Boston railway and the electrification of the six-track Harlem River division from New York City to New Rochelle. The last-named, together with the equipment of the enormous freight yards concentrated in this division, was of a magnitude which the public does not realize as the work was done without ostentation. The Hoosac tunnel electrification was remarkable for the quickness and freedom from accident which marked the completion of a most difficult undertaking. The electrification of the Harlem River division is closely connected with the plan for bringing New Haven trains into New York over the projected New York Connecting Railway and the Pennsylvania tunnels under East River.

In power station work several big operations now in progress command attention. The Commonwealth Edison Company, in Chicago, is building one of a pair of twin steam stations which will eventually contain six 20,000 K. W. turbo-generator units each. One of the interesting and suggestive features of this undertaking is that the station is being built in advance of the demand for its output so that the construction can proceed in the most efficient manner. The work is progressing rapidly, however, and the station will be in operation within a year. Like the great telephone companies the Commonwealth Edison studies the prospective growth of its business and prepares systematically to meet the demand as it materializes.

Last November a generating unit similar in size to those to be used in the Commonwealth Northwest station mentioned above, was successfully put into commission in the Waterside station of the New York Edison Company. This great engine is capable of producing 30,000 h. p. continuously and at present is the largest electric operating unit in existence. Across the Mississippi River at Keokuk, Iowa, the great dam is rising rapidly and electric power will soon be distributed over the surrounding territory. This project is worthy of the spirit of enterprise and audacity of the Middle West. In the far West the Los Angeles aqueduct development has reached such a stage that it is beginning to force itself on the attention of the public. The work ranks next in importance to the Panama and the Erie canals. The aqueduct, of a length of more than 200 miles, is nearly completed and designs have been prepared for the first municipal hydroelectric power plant of a capacity of 30,000 k. w. Power will be distributed in Los Angeles over a municipal system of mains and sold at a very reasonable rate. It is expected that profits of the enterprise will provide a net surplus of $700,000 per annum, deducting expenses of operation and fixed charges.

Electrical development in the South is keeping pace with that in other parts of the country. The progress of the Southern Power Company indicates the possibilities in power generation and distribution. While the company was handicapped somewhat last year by shortage of water, its steam auxiliaries will prevent a recurrence of power shortage. It is a great system and illustrates what will be increasingly the standard practice of several stations, tied together electrically to enable them to co-operate in furnishing reliable power.

In conclusion it should be stated that the foregoing paragraphs are not intended as a summary of electrical progress during the past year, but as the title indicates, are matters which have appealed to the writer as significant of present tendencies. In his opinion the outlook for the coming year is excellent and the electrical industry offers as promising a field for intelligent effort as ever.

The Water Power Development of the South, Present and Future.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

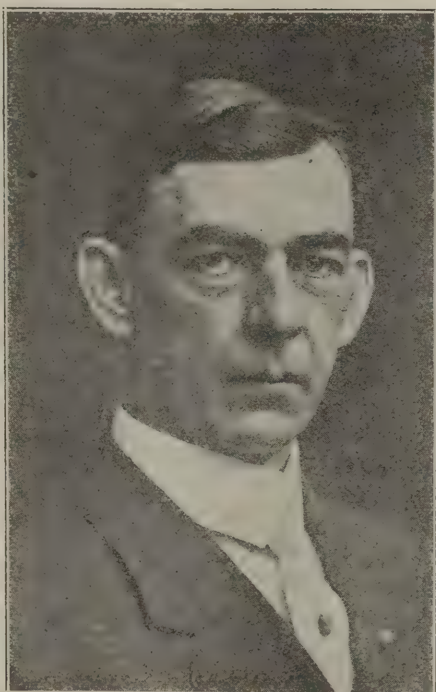
BY J. E. SIRRINE, CONSULTING ENGINEER.

WHEN the South began to recover from the lethargy of despair succeeding the Civil War, its first real start in manufacturing depended almost wholly upon the utilization of its small water powers. The early history of its industrial progress therefore is closely linked with the development of this source of energy. Just after the war, the price of coal and the poor economy from steam engines made the utilization of water powers a necessity for manufacturing enterprises and as a consequence, most of them were located at points not necessarily on the railroads, but at some place where power could be obtained cheaply.

Succeeding this stage there came, with the improvement of engines, a period wherein manufacturing plants began to seek the railroads, and to depend upon steam for their source of power supply. This condition did not prevent the development of some water powers, but it did change the previous condition of industrial expansion. With the commercial introduction of long distance electrical transmission, came the first real impetus to the utilization of water powers, and their growth followed step by step with the increased knowledge in handling and utilizing high voltage currents.

The first of these hydro-electric plants were developments of small powers to be transmitted within a radius of 10 or 15 miles, and usually to one point and quite often to one customer. Among the earliest of such plants in the South, were those at Columbia, South Carolina, where the power was transmitted a very short distance for cotton mill and city service. At Pelzer, South Carolina, power was carried about two miles at what would now be called low voltage, and used entirely by the Pelzer Manufacturing Company, and at Anderson, South Carolina, which is really the first of the high voltage transmission lines built in the South. At this latter plant, power was carried about 10 miles at a pressure of 10,000 volts. The fact that this Company is operating successfully today, with its original machinery, is one of the best evidences that the growth of this industry was normal and founded on a substantial basis.

The earlier hydro electric plants usually consisted of one power station, and depended upon one development for the maintenance of their service which was, of course, more or less irregular and subject to many interruptions. In many cases these interruptions were due to troubles on the transmission line, or to lack of proper lightning protection at the generating station; but very often the shut downs were due to either low water or floods.



J. E. SIRRINE, MILL ARCHITECT AND HYDO-ELECTRIC ENGINEER.

Many plants were designed with a very meager knowledge of the flow of the streams on which they were located and, as a consequence, a great many of the dams were not built to stand excessive floods, and in nearly every case, more power was sold than the plant was able to produce during the periods of extreme low water. As a consequence there were several failures of large dams and still more often a cessation of power supply to some of the customers, due to low water. This last condition has in a great many cases been remedied by the introduction of relay steam plants, and it is also very gratifying to note that in ten years no important masonry dam in the South has failed during flood. With the rapid industrial expansion of the last few years, it was found that the existing power plants large enough to serve the community at the time of their construction, were totally inadequate to take care of the situation after a short time, and that more and larger plants were needed to meet the increasing demands of every industrial community. It was also found that being dependent upon one generating station and one transmission line was more or less hazardous to the customer, and that the interruptions of service were becoming of more serious import, as the necessity for steady power became more and more apparent to the purchasers. The exactions placed upon the service were never more stringent than they are today, and it is due to this that the large power companies are now spending thousands where they formerly spent hundreds to improve and perfect their service.

Like every new business the water power developments in the South have been variously viewed; either as a gold mine or a flat failure, and, as is usually the case, neither the optimist nor the pessimist were entirely correct. Many thousands of dollars have been wasted in development of powers that cost a great deal more than their producing value would warrant, and on the other hand, many powers are lying idle that with sufficient capital and proper administration, would be highly remunerative. It is, how-

ever, gratifying to note that the developments of the present day are being undertaken on a large and comprehensive scale, and, as a consequence, the management is able to employ skilled engineers to design, as well as experienced men to both construct and operate these plants. The large manufacturing industries of today are well posted as to their power costs; and they are also keenly alive to the necessity of a continuous service and uniform speed. Therefore, any power company to serve them, must either give them the same thing they can get with steam at a cheaper price, or else they must give them something better, and most of the failures of power companies can be attributed to the total ignoring of these two things.

It has been the unfortunate experience of the writer to have reported adversely on at least 85 per cent of the proposed water power developments that he has been consulted on, and in several cases he regrets to say that he has earned the lasting ill-will of people who should have been thankful that they had not invested their money in a losing enterprise. While it may seem a strange and perhaps incredible statement, it is the honest opinion of the writer that a very few of the many water powers of the South are worth developing under present conditions, and only then by people with ample capital and good organizations.

The low rainfall of the past year, and especially of the period from July 1910, to July 1911, has shown conclusively that in order to properly protect its customers, a power company must have ample resources, at least commensurate with the needs of the community which it seeks to serve. Mere bigness is not the only test of probable success, but it is usually an index of what may be expected in service, for a company owning many plants and having large resources can easily and quickly remedy a deficiency, where a smaller company with limited resources cannot.

There are perhaps a half dozen water power plants in the South that are serving a number of customers from a single plant, doing it successfully and satisfactorily, but the great majority of them are not doing so. It is usually because the promoters knew nothing whatsoever of the extent of the work they were undertaking. They have, therefore, struggled along, doing the best they could without profit to themselves and very often, with loss to their customers. About four years ago, the writer in an article written for the *Manufacturers Record,* on the line of Future Development of Water Powers in the South, laid a great deal of stress on the fact that the success of the industry would depend upon the economical utilization of all the rainfall of the water shed and the intervening time has shown that this statement was true. It is manifestly impossible to build up the low water flow of a stream, except through the storage of large quantities of water at such points on the stream as the reservoirs can be kept clear of silt. To undertake the construction of such reservoirs for a single plant, except under peculiar or high head conditions, is apt to prove too big an undertaking to be commercially feasible, and it is therefore necessary that these storage reservoirs should serve a number of plants instead of one.

There is a growing demand for cheap power for electro-chemical uses and this demand must be supplied in large quantities at points where transportation is available and the price of this power must be extremely low. It is manifestly out of the question for a small company to put in a large amount of auxiliary apparatus to be used during seasons of high water, and it is also manifest that the storage reservoirs of a large company would, unquestionably, even up a flood period to such an extent that this power sold principally as a by-product, would be available for a very much longer period than would be the case with the ordinary plant having its storage confined to the dam at the power station.

To what extent electro chemical processes are developed in the South will depend almost entirely on the magnitude of the water power operations and upon the ability of the power companies to successfully finance the purchase of large quantities of auxiliary apparatus on a low interest basis.

It is also sometimes quite an advantage to have a distribution system supplied from generating stations located on different water sheds, for the reason that quite often the rain fall may be much nearer normal on one water shed than another. Although, whenever the physical conditions permit and other things are equal, it is advantageous to construct the plants in such a way that the storage of one will benefit the other, and in this way utilize every drop of water that is in the stream by passing it through the wheels at each successive station, instead of letting it go to waste over the dams.

The development of large systems of hydro-electric transmission plants in the South has been very recent, but the experience of both the producer and consumer has shown quite clearly that it is decidedly to the advantage of both to have the territory fully covered by one corporation. The agitation for the conservation of natural resources which was so admirably begun has, unfortunately, been swerved from its original course, and in the case of water power utilization has certainly taken a turn that is prejudicial to the interests of those whom it should be anxious to serve. It is quite certain that the use of a resource that is inexhaustible does not impair its value, but on the other hand, this use must result in the saving of some other source of energy which it displaces or prevents more serious inroads on.

We are constantly being warned by those in a position to know, that our coal supply is being drawn upon to such an extent that only the discovery of new deposits or very deep mining will prevent our having a coal famine within what may be a comparatively short time, and yet very frequently, these same people will persistently attempt to block the development of a water power plant, which is of course, the only known way we have of substituting some other power for that derived from steam. Coupled with this demand that the Government shall prevent the absorption of the natural resources by corporations is the hue and cry about monopolies that are being formed to control the industrial South by reason of the complete corralling of its water powers. As a matter of fact those charged with being the greatest malefactors are not as a rule remotely interested in the plants with which they are charged as being in control of; but the real danger lies in having the public mind educated or inflamed to a point where it will protest against the formation of large companies to take over all the available powers within a certain district and develop them upon a large and comprehensive scale.

As a matter of fact, the experience of those who know has shown conclusively that only by the formation of these large companies, can the real problem of getting the most out of our Southern water powers be attacked with any hope of proper solution. The first thing necessary for the development of any particular power, is money, and this can only be had upon the promise of safe investment and an adequate return, which return must be somewhat in keeping with the risk involved.

Therefore to duplicate transmission service and operating costs without raising the price to the consumer, cuts the profit of the investor to such an extent that he cannot afford to invest in the enterprise. With the steady improvements being made in heat engines, and with the increasing size of individual manufacturing plants, it is manifestly impossible for the prices to be raised to the consumer at least under existing conditions and those likely to be in effect for sometime. With steam as a most formidable competitor and the ability of the power producer to increase his revenue being limited by steam competition, he must in the long run depend upon the progress of the community in developing its small industries which are of course ideal customers for power companies. The serving of many small customers also means an increase in the secondary distribution system and in an enormous multiplication of attention and clerical work, all of which must be taken into account in arriving at the net revenue.

It is quite often thought that practically all the cost of a hydro-electric plant is in the construction of a dam and power house, whereas it is doubtful if more than 50 per cent of the investment of a power company is in these particular items where a large territory is properly covered.

Many of the larger streams of the South either because they are navigable at the lower portion of their length or are the line between the two States, are under the control of the National Government, and upon its policy of dealing with prospective power companies will depend to a very large extent, the future of such corporations in the South. That we must come to either a federal or State regulation of prices for all public corporations is almost certain, and that such regulation may be desirable for both power companies and customers, is highly probable. There should not, however, be any restrictions which should prevent the uniting of existing companies, both physically and financially, or which would prevent a company from purchasing powers in addition to the ones already operated.

The subject of relation of navigation to development of water powers on streams that have a considerable flow, is too broad a one to be treated in this article and has been covered so often to make it unnnecessary; but the fact that the two are not antagonistic has been clearly proven.

Briefly then, in the writer's opinion, not only the present but the future growth of hydro-electric plants in the South will be determined largely by the policy exercised in Governmental control. Any complete utilization of these resources will be only possible by the public recognition of the necessity of large powers built to properly serve not only the present but the future needs of the industrial community reached by their transmission lines, and until there shall cease to be a protest against this natural and logical growth, it will be very difficult to interest capital in an enterprise which depends very largely upon the policy of liberal treatment by the public authorities and upon the future growth of the territory they cover.

Canadian Hydroelectric Power.

According to the monetary Times of Toronto, figures as to the financial position of the Ontario Hydroelectric Commission have been announced by Hon. Adam Beck, chairman of the commission. The total estimated cost of the scheme was $4,006,927, and the line has been completed at a total investment of $3,921,167.97, with all interest charges paid up to November 1. As apparent from the figures, there is a balance in hand of $85,760, and Mr. Beck said that not more than one half of this amount would be required to cover all the construction and maintenance charges for the service for the fiscal year beginning November 1, 1911, and ending November 1, 1912.

The service began with 12 municipalities taking 24,000 horsepower; to-day 28 municipalities have made contracts for 33,000 hrosepower, and have become tributaries to the enterprise. Almost every week municipalities are voting on the power question, and the service is increasing very much more than they had anticipated, said Mr. Beck. Computing their estimates on the present consumption and on the probable new contracts which will be assumed during the coming year, Mr. Beck said they were submitting to the Government a statement that the average load of power for 1912 will be 19,470 horsepower. On this basis of calculation, the total estimated revenue of the hydroelectric service for 1912 (that is, from Nov. 1, 1911, to Nov. 1, 1912) will be $463,828.

The total average load of power carried for the past year was 13,470 horse power, the total amount of power paid for at the falls being 12,100 horsepower, so that enough extra power was sold to cover the cost of all line and transformer charges. Contrary to their original intention, Mr. Beck said, the charges had been made against capital instead of sinking fund for the plants installed up to November 1, next. Thereafter the levy will be made against the sinking fund. But, Mr. Beck remarked, should any municipality desire it, the commission would waive these charges against sinking fund for one or two years more, so long as the charges were met in 30 years' time. Municipalities that joined the service in 1914, under the 25 years' contract, would be required to pay an interest of 2.4 instead of 1.8 under the 30 years' contract, on the sinking fund.

Hydro-Electric Plants in South America.

Several hydro-electric power plants are being constructed, principally by German interests. So far as known there is but one plant in the country owned by American interests, and that is connected with the Braden Copper Co. near Rancagua, Chile. German interests control a large proportion of the electrical plants of the country and are reaching out for the most available sites for hydro-electric plants. A German company secured a concession last year for the location of a water power plant on the Aconcagua River above Valparaiso with a view to supplying power and light to the region above and about this city. They so dominate this business that it is difficult to introduce anything but German electrical machinery and supplies.

The Trend of Industrial Plant Engineering and Part Taken by Underwriters.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY A. M. SCHOEN, MEMBER A. I. E. E.

WE appear at last to have passed out of the zone where that threadbare expression, "electricity is yet in its infancy" was a common phrase. The public at large is being brought to a realization that electricity has become the most important factor in the world of manufacture, commerce and general utility of any known form of energy. In the very early days, when only the direct current was known, while the realm of conjecture was large its ultimate value was indeed problematical. Within short distances it offered all that could be desired but its transmission to points at all remote offered such difficulties that its use beyond a certain radius was commercially impracticable.

The advent of alternating current and the static transformer opened up a field absolutely impossible to the direct current. Since electric energy was generated as the result of copper wires traveling through a plane traversed by lines of force in such manner as to cut these lines, it would seem most natural that the converse of the propositions should be attempted—having the wires stationary and so moving the lines of force as to be cut by the wires, thus obtaining a translating device. However obvious and simple this process of reasoning might seem at this day in the light of past experience, not so very many years ago, the problem presented of accomplishing practical results in this direction was intricate to say the least. After the first successes with small machines and what would now be considered low voltages, there were fundamental difficulties still left to be overcome as to insulation, core metal, etc., before the larger apparatus and high voltages of today could be even attempted. But from the time a real start was made in this direction the strides taken increased at a rapid rate until today such systems as the Southern Power Company with its sixteen hundred miles of transmission lines in the Carolinas have become not only possibilities but actually accomplished commercial facts. Water powers which until within the past few years were practically worthless on account of their inaccessibility and remoteness from the market, have been harnessed and made of extreme value, while the flexibility of the power and the convenience and cleanliness of the light from an electrical source, has appealed to manufacturers, merchants and citizens generally throughout the country. Today even the small hamlet can afford the luxury of electric lights and the farmer can gin his cotton by electricity, Starting with one hundred and one thousand, the operating voltages have gone with leaps and bounds through successive stages until today one hundred thousand volts is maintained on some of our greatest power lines.

A. M. SCHOEN, MEMBER A. I. E. E., AND CHIEF ENGINEER SOUTH-EASTERN UNDERWRITERS ASSOCIATION.

While on direct current systems one hundred and ten, two hundred and twenty and five hundred volt direct current motors gave good service in the larger cities, it was long before the electric motor was taken seriously as a source of power in large manufacturing plants. Central stations were comparatively small and the loads carried were not large enough to draw the serious attention of the officials to the value of acquiring a non-peak load. In the smaller cities the plant was only operated at night, so if there was a street railway, current for motors had to be supplied from the trolley circuit or done without. The single phase alternating current motor, until one was brought out by the Wagner Company which gave fair results, was not known and altogether the field of commercial power was not in an especially attractive condition. Then came the two phase motor with sufficient starting torque, followed not a great while after by the thoroughly practical three phase apparatus and both manufacturer and engineer realized that the day of electric power drive for industrial plants had dawned. At first all of these motors were operated at low voltages, four hundred and forty volts being a maximum, then five hundred and fifty and finally in order to do away with the second transformation the voltage went to twenty-three hundred.

With these changes and progress, however, much had to be accomplished along collateral lines, since the old devices, materials and attachments were totally unsuited to the demands made upon them by greater currents at the higher voltages. Much criticism of the underwriters was indulged in because their rules were so often changed, in fact this criticism became a habit with many officials of electrical industries that did know or should have known better.

In line with this thought it may be well to review the growth of the underwriters' work and point out a few of the problems. Previous to 1895 each section of country had its own electrical rules enforced by the underwriters

having jurisdiction. Among these could be mentioned the New England Insurance Exchange rules applying in the New England States; rules of the New York State Board; rules of the Underwriters Association of the Middle Department covering the Middle States; the Western Union covering the Middle West; the Southeastern Tariff Association covering the Southeastern States below the Potomac River; the Board of Fire Underwriters of the Pacific and others. The confusion incident to this state of affairs can well be imagined. There was no definite method of passing on either devices or materials and no definite standard by which they should be manufactured. Naturally there came a strong demand throughout the country for uniform rules for construction in all parts of the country and in the years from 1892 to 1895 representatives of a few of the larger insurance organizations held meetings and with the New England Insurance Exchange as prime mover made strenuous efforts to bring into line a large enough part of the United States to evolve a uniform set of rules. This was finally accomplished at a meeting held in New York in 1895, and a committee which was appointed, having selected the best rules from the requirements of the various sections, a pamphlet known as the Rules and Requirements of the National Board of Fire Underwriters for safe electrical wiring was published under the auspices of the National Board of Fire Underwriters and recommended for general adoption. Later, about 1897, the Underwriters Laboratories at Chicago under the control of Mr. W. H. Merrill, Jr., became a potent factor in the work and in 1898 at a meeting of the committee called in Chicago, the work of these laboratories was collated and the first edition of the Supplement to the Construction Rules of the National Board was issued listing the various devices and materials which had been tested and found suited to the service for which they were intended. It must be borne in mind that before these tests could be made, it devolved on this committee known as the Electrical Committee of the Underwriters National Electrical Associations, to evolve standard rules for testing each separate class of devices and materials. This involved enormous work on the part of sub-committees all through the year, including conferences with manufacturers and manufacturers' committees, wide correspondence and investigation of practical field results as well as time spent in factories and laboratories where tests could be made under the varying conditions necessary to reaching a fair and safe conclusion. Only those of us who bore the heat and burden of the early days of this work have any conception of what it meant. Of those who devoted their time and energy to it at that time, it is safe to say if it were to be done over again, few if any who were the pioneers would care to undertake it.

In later years the National Conference Committee consisting of representatives appointed by the various engineering societies as well as the Underwriters became a fixed organization and met annually immediately following the meeting of the Underwriters National Electrical Associations, to discuss the various changes in the rules. Most of these delegates would also attend the meeting of the U. N. E. A. and take part in formulating the revision of the rules. The National Electric Code replaced and superseded what had been formerly known as only the Underwriters Rules. The Underwriters' Laboratories were extended correspondingly in equipment and service furnished as the demand became so great that a very considerable corps of engineers had to be maintained for testing at the laboratories and carrying on the label service at the various factories.

Changes in engineering practices were closely followed by corresponding changes in the rules at the annual meetings and in an effort to keep in close practical touch, a standing sub-committee was maintained to visit such works as those of the General Electric and Westinghouse companies and spend several days there in factory tests and conferences with the factory engineers. On every subject taken up the operating or manufacturing interests most affected were consulted with freely and no effort spared to obtain the most practical advice from all sides. Some of the work done by the sub-committees was most tedious and long drawn out, some of it covering years of research and investigation, as for instance, the subjects of "Switches and Cut-outs"; "High Tension Motors"; "Grounded Neutrals and Secondaries"; "Circuit Breakers," etc. All of this work, while tending primarily in the direction of safety to both life and property, secondarily provided both manufacturer and contractors with standards on which competition could be fairly based and exerted a power seldom realized in the progress and upbuilding of electrical service as a whole. The work of the Underwriters is an integral part of this entire work and when given its proper place and viewed by an unprejudiced mind, its inherent value must be realized. Perfection in either systems ormen is not to be expected nor is it attained in this work, but when the algebraic sum of the good and the bad has been taken the true value will be realized.

After a consideration of what has just been outlined, every electrical engineer who has kept abreast of the times knows that with the rapid changes in apparatus and current supply had the underwriters failed to make correspondingly frequent changes in their requirements, which has been the chief criticism against them, they would soon have become obsolete and a laughing stock. It must be borne in mind that installation, materials and devices have followed the development of the generating and transmitting apparatus and never was the reverse true. It was only demand for these things that brought them into existence and the Underwriters' requirements were the most important and insistent factor that resulted in securing a reasonable factor of safety and reliability in these materials. Imagine using a baby knife switch or a one hundred and ten volt plug fuse on a five hundred and fifty volt circuit. Conceive of a two hundred and twenty volt open knife switch controlling a twenty-three hundred volt motor and located in the mill at the machine and within easy reach of the employees; think of two alternating current wires of opposite polarity and conducting large current drawn into separate iron conduits and you will have some idea of how some work would have been done had the Underwriters rules been left unchanged. If contractors were not forced to use suitable materials, the incentive to make the cheapest and poorest which would have had an excellent market, with a corresponding drawback in development.

The tendency under competition is and has always been to use the cheapest possible material that will accom-

plish the end to be arrived at. An excellent example of this is found in the flexible cord, the poorest grade is that which has been allowed and described expressly as a "pendant cord" and yet in four cases out of five when a portable light or fan is installed this same cord will be used in spite of the fact that a "portable cord" made with extra insulation and braid is specially called for. The reason of course is that the pendant cord is the cheaper, and if the rules in order to overcome this were to refuse to recognize the lower grade cord at all and demand the portable for both classes of work, it would be considered arbitrary and qute a hardship.

In all of these matters, the proper plane must be reached eventually and had the Undewriters not voluntarily assumed this function, the central station officials would sooner or later have found themselves compelled in self-defense to interfere and carry on the work of first formulating and then enforcing proper rules for construction. With their other duties confronting them, they would have been slower and found it much more difficult to achieve their ends, than have the Underwriters, and would also have found the work a material item of added expense.

It is much easier to tear down than to build up and there are few men unable to find something to criticise in what others have done. There are few outside of those who have labored together all these years for the establishment of a National Electrical Code who have any conception of what a monumental undertaking it has proven and how many hours of patient and painstaking work have been given to bring it to its present state.

Recent Developments in Hydro-Electric Engineering in the Northwest.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY C. A. TUPPER.

The System of the Great Northern Power Company.

ON a recept trip through the Northwest the writer found, in one community after another, evidence of the increasing activity in the commercial utilization of water powers. High head developments undertaken or completed during the past year include two 4,000 H. P. units at 720 R. P. M. for the 550 feet head, Carp River plant of the Cleveland Cliffs Iron Co., at Marquette, Mich.; four units of 8,000 H. P. at 450 R. P. M., 415 feet head, constituting a complete municipal plant for the city of Tacoma, Wash.; two 3,000 H. P. units, 600 R. P. M., to be added to the 365 feet head plant of the Knight Power Co., Heber City, Utah; two units averaging 3,000 H. P. each, 450 and 600 R. P. M., to run under 200 feet head for the Davis & Weber Canal Co.; and five 3,600 H. P. units, 107 R. P. M., 25 feet head, for the Boise Project of the United States Reclamation Service. Other developments, perhaps equally notable, the details of which there will not be space for here, are those of the Wisconsin Power Co., at Prairie du Sac, Wis.; Chippewa Valley Railway, Light & Power Co., Eau Claire, Wis.; Northern Hydro-Electric Co., Green Bay, Wis.; Minneapolis General Electric Co., Taylors Falls, Minn.; Five Channel Development Co., and Cook Development Co., Bisonette, Mich.; Peninsula Power & Development Co., Iron Mountain, Mich.; Menominee & Marinette Light & Traction Co., Menominee, Mich.; Butte Electric & Power Co. (Great Falls), Butte, Mont.; United Missouri River Power Co., Helena, Mont.; Great Northern Railway Co., Cascade Plant; Washington Water Power Co., Spokane, Wash.; Pacific Coast Power Co., Seattle, Wash.; White River Plant; Olympic Power Co., Port Angeles, Wash.; American Power Co., Seattle, Wash.; Mount Hood Railway & Power Co., Portland, Ore.; Hanford (Wash.) Irrigation & Power Co., Portland, Ore.; and Portland Railway, Light & Power Co., Estacada Plant.

In connection with these developments the most important tendencies to be noted are the increasing use of the reaction type of turbine, the endeavor to eliminate wastage of water and the closer co-operation now existing between designing and constructing engineers. Not many years ago the field of application of reaction turbines was limited to heads not exceeding 400 feet, and above that limit impulse wheels were exclusively used. As a result, however, of the increase in the magnitude of power system, the capacity of the individual units had to be greatly enlarged, so that their relative number might be kept small and power house costs thus restricted within reasonable limits. These requirements led to extending the field of usefulness of reaction turbines. Their special adaptability to modern high head service is due not only to the fact that with them higher speeds can be used, thus keeping down the cost of the electric generators, but also to the additional advantage that the size of the wheels can be made sufficiently large to produce such higher speeds without the necessity for special generators. In the matter of capacity and speed, therefore, they strike the happy mean.

The practice of wasting water, formerly general, had to be abandoned because the capacity of the power plant was otherwise limited by the minimum supply of water available from the ordinary flow of the river. Now the effort is to avoid waste in every way possible, and to store up that part of the flow which is not required during a portion of the day, in order that it may be made available for peak loads.

It has, therefore, become necessary to operate hydro-electric machinery in accordance with a water-saving program. This involves an entirely new problem of regulation, because such regulation means a change in the velocity of the water column according to load changes in the system. If this change, particularly the fly-wheel effect of the rotating parts, is not duly considered in the selection of the machinery, and such means adopted as are necessary to protect the pipe line, disastrous results may follow.

The hydraulic engineer on the manufacturing end and the hydraulic engineer on the construction end are now obliged to get together so that problems can be mutually

Mr. Tupper has recently returned from a trip abroad where he made a study of water power development on behalf of the Allis-Chalmers Company, of Milwaukee, Wis. The data presented in this article gives his observations on a recent trip in this country.—Ed.

solved. The manufacturer will provide units of specially adapted fly-wheel effect and governors of such design as to meet the particular conditions involved, and also safety devices for the protection of the pipe lines against heavy fluctuations of pressure caused by the heavy load variations of the power system; while the hydraulic construction engineers will proportion the pipe lines, inlets and surge chambers or standpipes in such a way that they work in harmony with the characteristics of the generating units and their accessories.

One of the best examples of the success, in practical application, of the principles above enumerated, together with the further provision made for drainage regulation over a large area, by means of storage reservoirs, is to be found in the system laid out and partially constructed by the Great Northern Power Co., of Duluth, Minn. The entire project calls for the ultimate development of about 100,000 H. P. in two different plants. The power generated in these plants will be distributed at the head of the lakes, including service to industries in Duluth and Superior, and probably ultimately transmitted to the mining regions of the Mesaba and Vermillion ranges.

GENERAL PLANS OF THE DEVELOPMENTS.

The first of these projects, and the one which has now been partially completed, is located near Thompson, and takes water from a drainage area of approximately 3,560 square miles. The second plant of about 15,000 H. P. capacity, which is projected, will be located just above Fond du Lac, where a head of 70 feet will be utilized in a power house located below the dam.

The plans for the Thompson plant contemplate an ultimate installation of 80,000 H. P. under a head of 378 feet. The head works and canals have been constructed for this total capacity, but the station itself and the penstocks conveying the water to the turbines, as now installed, provide for only 40,000 H. P. The accompanying plan and elevation show the St. Louis River from a point above Thompson to Fond du Lac, Minn., and give the general layout of the development. A dam was constructed at Thompson and a service reservoir formed, from which a canal two and one-half miles long was built, terminating in a forebay with head gate structure controlling admission to the penstocks. At present three penstocks of wood stave pipe each seven feet in diameter are laid for a distance of 4,000 feet, and from that point to the power house, a distance of 1,000 feet, riveted steel pipe is used, making available a fall of 378 feet.

The service reservoir has an area of three-quarters of a square mile and serves to equalize the flow. It has sufficient capacity to operate the full equipment of 80,000 H. P. continuously twenty-four hours without supply from the river with practically no loss of head, and provides for the time interval required before water can be received from the storage reservoir in case of sudden requirement. The main dam is built of concrete, 1,120 feet long, and has a spillway with a curved crest 365 feet long, 38 feet in height and 42 feet wide at the base. This is shown in Fig. 1, which also gives an idea of the three sluice gates provided, each 7 by 9 feet. The retaining walls of the dam and all fills about the reservoir are six feet higher than the crest of the spillway. A rock ridge extending west from the main dam has been cut down to an elevation one foot higher than the spillway of the main dam for a distance of 1,000 feet. This provides additional overflow capacity in case of excessive floods. Two of the small dams necessary are of earth construction faced with riprap. One is a rock-filled dam with a concrete core wall and the other seven dams are of concrete.

The service reservoir and the low velocities in the canal have effectually prevented trouble from surface or needle ice, in spite of the severe climatic conditions. Water is drawn from the bottom of the reservoir into the canal through submerged arches provided with head gates. The design is such as to keep velocities of approach low, and practically no ice or other floating material enters the canal. Eight gate openings 6 by 9 inches are provided, only 3 of which are fitted with gates, the others being temporarily closed. The east end of the canal mentioned above terminates in a forebay covering about 40 acres, which serves to equalize the flow. This is formed by an earth embank-

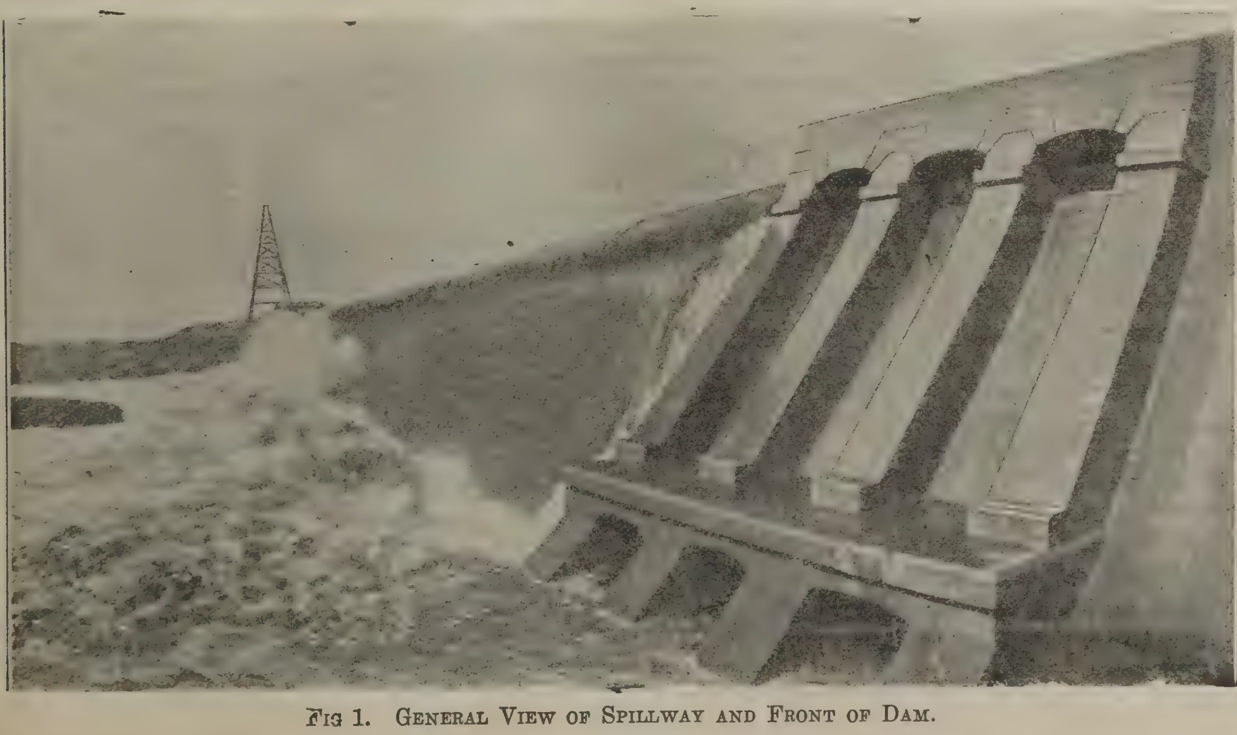


FIG 1. GENERAL VIEW OF SPILLWAY AND FRONT OF DAM.

ment 3,500 feet long and 30 feet in average height, having a core wall of planking. The embankment is 25 feet wide on the top with a water slope of one to two and one-half and an outside slope of one to one and one-half. Both sides of the embankment are covered with riprap. The forebay provides for sudden fluctuations without necessitating a change of the head gates at the service reservoir. Water is drawn from the forebay into the penstocks through head gates set in concrete and protected by a gate house.

PENSTOCKS AND SURGE TANK.

In the lower head works openings for eight pipe lines are provided, three of which are now built. The penstocks are each seven feet in diameter and about one mile long. They are laid in trenches and buried. Wooden stave pipe of California redwood staves three and one-half inches thick is used for about 4,000 feet. The maximum pressure of this part of the line is equivalent to about 150 feet head.

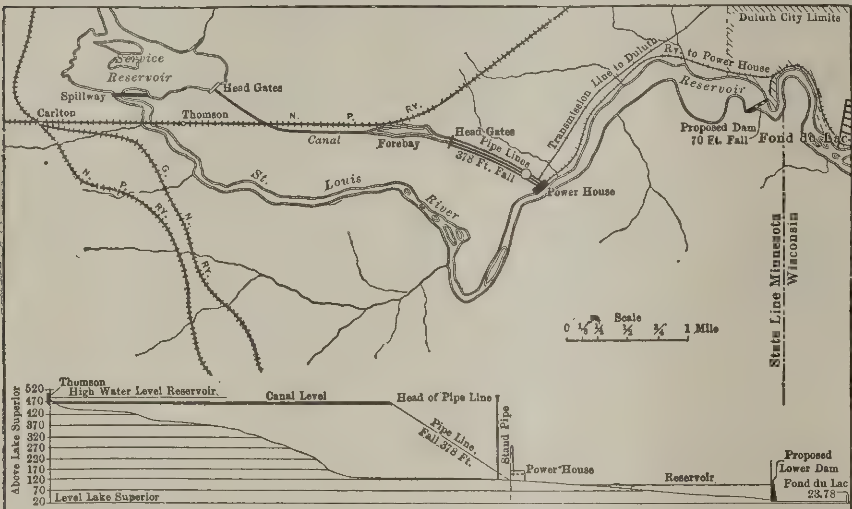


FIG. 2. GENERAL PLAN OF HYDRO-ELECTRIC DEVELOPMENT OF GREAT NORTHERN POWER COMPANY.

The lower 1,000 feet of each penstock is of riveted steel plate and operates under heads varying from 150 feet to 375 feet. The two parts of the pipe line are joined by special construction consisting of a cast iron bell-shaped piece into which each is thoroughly caulked with lead and oakum. This wood stave pipe line is shown in Fig. 4.

The surge tank or standpipe is located about 500 feet from the power house at the top of the bluff, the relation of the two being shown in Fig. 4.

POWER HOUSE AND HYDRAULIC EQUIPMENTS.

As previously mentioned, this development will eventually have 80,000 H. P. capacity, but at present the building is designed to accommodate only half of this installation. The complete power house will be 77 feet wide, 313 feet long and 90 feet high. The foundations are of monolithic concrete laid in a sandstone ledge which underlies the site. The superstructure has a framework of steel with brick curtain walls and concrete block trimmings. The roof is of tile, covered with four-ply roofing felt laid in asphalt with tar and gravel and supported on steel trusses. The interior walls are finished in buff and white pressed brick with the exception of the generator room, which has a wainscotting seven and a half feet high of white enameled brick. A basement 18 feet in height extends under the entire building and contains the penstocks, turbines and auxiliary pumps. On the main floor the generators are located in line along the river side of the building, over which a 60-ton crane travels. Opposite each generator is a three-phase transformer of corresponding capacity located in a separate compartment provided with iron doors opening on to the generator floor. A second floor extends from the top of the transformer compartments to the opposite wall of the building and carries the low tension and high tension switching apparatus and the switchboard. In front of the switchboard and over the generator room a balcony is provided to give a full view of the floor. A division wall divides the space back of the transformer compartments into low tension and high tension bus-bar rooms.

There are now installed three Allis-Chalmers vertical reaction turbines of 13,500 H. P. capacity each, under a head of 360 feet when operating at 375 R. P. M. Each is direct connected to a 7,500 K. W. 3-phase 25-cycle generator. Each of the penstocks, on entering the power house, is reduced from 84 inches to 72 inches and connects to a hydraulically operated gate valve bolted to the turbine casing. Each gate valve weighs thirty-one tons and is 28 feet in overall length. The turbines are three in number, each of a nominal capacity of 13,500 H. P. at 375 R. P. M. under 360 feet head, but have shown 14,500 H. P. on test, and at the time of their installation were the largest ever built. They are of the Francis reaction vertical single runner spiral-case inward discharge type, and the rotating parts of both turbine and generator are carried on oil pressure thrust bearings.

ELECTRICAL EQIPMENT.

The three main generators are each vertical 7,500 K. W. 375 R. P. M., 25 cycle, 6,000 volt, 3-phase, direct connected to the turbine shafts. They are guaranteed to carry 50 per cent overload continuously without undue heating. Excitation for these is furnished by two 250 K. W., 8-pole, 125 volt, direct current generators, direct connected to exciter turbines. The transformers are each 7,500 K. V. A., 3-phase, 6,600 volt to 30,000 or 60,000 volts, and are cooled by circulated oil passed through a special cooling arrangement located, with the necessary pumps, in the basement. Each transformer is located in a fireproof compartment fitted with iron doors opening on to the generator floor, and is arranged so that it can be moved out on rails and handled by the power house crane.

Current from the generator passes through a motor operated oil switch located on the second floor to the low tension bus located in a compartment in the rear of the transformer compartments and provided with sectionalizing switches. A transformer switch makes connection between the low tension bus and each transformer, and an arrangement of tie buses and disconnecting switches makes it possible for any generator to work through its transformer without connection to the low tension bus or to be connected to the bus independent of the transformer, thereby producing great flexibility. The transformers on the secondary side are connected to the high tension bus by a similar arrangement of tie buses and high tension motor operated switches connecting the two outgoing lines. The high tension bus structure is located between the low tension

bus compartments and the rear of the station; the switches are placed above in separate fireproof compartments on the second floor. The lightning arrestors are mounted on the rear wall, through which the outgoing lines pass. The layout is extremely flexible and enables any generator to be used with any transformer and either outgoing line. A bench board, located on an extension of the gallery overlooking the generator floor, enables one operator to control the entire station.

TRANSMISSION LINES AND SUB-STATIONS.

Two 3-phase circuits of No. 00 copper cable with hemp center arranged in the form of an equilateral triangle and spaced 72 inches apart are carried on steel towers to a sub-station in Duluth, fourteen miles away. A 100 foot right-of-way extends the entire distance, and the towers have been placed at one side of this, so as to provide space for a second set later. The towers are spaced from 300 to 1,000 feet apart, and are built in three heights, 40, 52 and 60 feet, for use in meeting the topographical conditions encountered. The towers at angles in the line are built especially heavy.

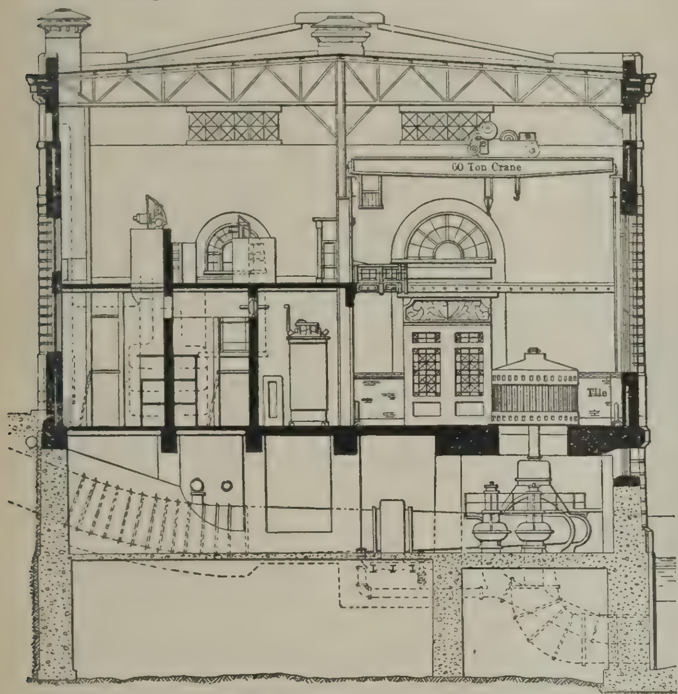


FIG. 3. CROSS SECTION OF POWER HOUSE.

The Duluth sub-station is centrally located, and contains three 7,500 K. W., 3-phase transformers, which are duplicates in every respect of those installed in the power station. They step down the voltage from 30,000 or 60,000 to 13,200 volts, at which pressure power is distributed to customers. The building also contains three 1,500 K. W. synchronous motor generator sets, transforming 13,200 volt alternating current to 600 volt direct current, for use in the street railway system in Duluth. From this substation the distribution lines go out underground until reaching the outlying districts, where they are brought overhead. Two 13,000 volt lines from this sub-station are at present carried under the St. Louis River by means of submarine cables to Superior, Wis., where power is distributed to the lighting and railway companies.

As an insurance against interruption, a second transmission line from the power station is now being constructed, following a different route from the present lines by crossing the river at the power station and following down the Wisconsin shore to a transformer sub-station in Superior.

The design and installation of the Great Northern Power Company's plant was developed and carried out by the engineering department of the Allis-Chamlers Company, which company also furnished the hydraulic and electrical apparatus installed. An indication of the degree of satisfactory operation of the plant, substantiating its careful design, can perhaps be best expressed by quoting from the letter of acceptance written by Mr. W. N. Ryerson, general manager of the Great Northern Power Co. to the Allis-Chamlers Co., under the direction of the board of directors of the former company.

"The recent efficiency tests made on the three main units by Mr. John C. Parker, electrical and mechanical engineer of the Rochester Railway & Light Co., showed excellent results. Slightly more than a year ago, we conducted a series of tests on No. 1 unit, having at that time a larger clearance between the turbine runner and guide vanes than was originally intended, and even in this unsatisfactory condition we obtained an efficiency at full load of 13,000 H. P., 1.5 per cent greater than was guaranteed by your company in the original contract. The recent tests, made after the clearance had been restored to its original amount, showed an excess in efficiency over that guaranteed in the contract at full load of 4 per cent, at 10,000 H. P. of 3 per cent, and 6,000 H. P. the excess was 2½ per cent. Since these tests were made the clearance on Nos. 2 and 3 turbines has been corrected, and I have no doubt that results equal to if not greater than those obtained on No. 1 are now possible on Nos. 2 and 3 units."

FIG. 4. THE POWER HOUSE, SURGE TANK AND TOWER.

The Relation of the Engineer to Civic Progress.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY FRANK F. FOWLE.

EVERY man owes it to society to exercise the prerogatives of citizenship in the interest of the greatest number. This sense of private obligation toward the public good is probably keener today than ever before, a fact which is evidenced by the awakening interest in our numerous problems of government. It is extremely significant that this interest extends beyond the mere correction of obsolete laws, now on the statute books, to the more vital matter of enacting new laws to correct modern evils and abuses and to protect the public welfare. The narrow arena of politics, in the old sense, conveys no adequate idea of the problems of the present and the future with which the public is now confronted, and to which progressive leaders in various walks of life are giving their earnest attention.

We have with us at this moment questions which concern not only ourselves, but future generations, and therefore we are charged with a double responsibility in solving these problems with the utmost regard for the public interest. Especially prominent among these matters is the conservation of our natural resources, concerning as it does so vitally our future supplies of fuel, our minerals and forests, our sources of water and water power, and the preservation of the soil. Closely connected with conservation is the preservation of our navigable waterways and the correction of economic conditions sufficiently to bring them into such use as properly they ought to enjoy.

FRANK F. FOWLE, CONSULTING ENGINEER AND INVESTIGATOR.

Among the serious problems in urban communities, of ever increasing size and population density, are those of procuring and distributing pure water for public use, and so disposing of sewage as not to endanger the public health. These fundamentally are all problems of engineering, which only the men of proper training and experience are fitted to solve. We may pass on to mention other questions of more immediate concern, such as the proper methods of regulating public utilities, the prevention of industrial accidents and the protection of workmen, the important matter of city planning and the abatement of the smoke nuisance. These, again, concern the engineer at many points and in a most intimate way.

Every alert, progressive citizen is vitally interested in these questions, in a personal sense, but unless he is specially equipped by education and experience, he probably realizes his inability to cope with them unaided. If it is every citizen's duty to inform himself on these questions and hold honest convictions which he can sustain in debate with laymen, how much more is it the duty of engineers to come to the front and contribute of their special knowledge, to the end that laymen may be properly informed and a sound public policy thus be established. It is fundamentally true that every man owes certain duties to society, and in particular the obligation of exercising the functions of citizenship to the best of his ability. But men come to this latter duty with greatly varying preparation and equipment. However, it is equally fundamental that those who have the most should give the most, and therefore the man of special education and experience owes the double duty of discharging the obligations of a layman and contributing of his expert knowledge whenever it may be of service in relation to public questions.

Thus the engineer is peculiarly fitted for the tasks of civic betterment, in common with all professional men of more than average education and training. The keynotes of modern progress along this path are co-operation and efficiency. The first of these is a human or sociological factor, which concerns us all, whatever may be our vocations. The second is even broader, since it applies not only to human efficiency, but also to the prevention of waste, or conservation of our resources of every kind. The engineer is naturally fitted to cope with the problems of conservation, because they have such an intimate relation with his work in almost countless ways. In proportion as his training and experience have been broad, so is he better fitted to deal with these questions. Even the pure specialist, however, is almost sure to touch the problems at some point.

The more we study conservation, the more we see that it ought not to be dealt with piece-meal, but as a great whole. For example, the preservation of our water sources, water power, navigable water ways and timber supplies are corelated problems in a physical sense. And even where no direct physical relation exists, there is often an economic connection. For illustration, the preservation and development of water powers is necessary to conserve the fuel supplies and maintain reasonable prices; otherwise we face

a diminishing supply and rising prices, with the necessity of drawing ultimately on the most inaccessible deposits and final famine. Again there is a direct physical connection between the several examples of conservation just given and the preservation of sources of pure water for domestic use, and the healthful disposal of sewage. These illustrations show the great necessity of co-operation in solving conservation problems in the wisest manner. Perhaps the conservation of water powers and timber are now receiving the most public attention; in this connection it is noteworthy that engineers and men of scientific training are playing an important part, and undoubtedly are contributing a great service to society, both present and future.

Civic progress on the industrial side also presents a wide field for the services of the engineer. The regulation of public utilities, as to rates and service, is receiving wide attention, and has already come into existence in one or another form in about one-third of our States. There are many fundamental questions here as to engineering, in the broad sense, relating to construction, operation, administration and valuation. This work presents many difficulties and perplexities, which need to be treated with the greatest care. As between the rights of the public and the rights of private property it is necessary to draw fine distinctions and adhere inflexibly to the doctrine of the square deal. There is a great tendency here to partisanship, according to where one's interests are, and too often the engineer who is presumed to be, or ought to be, fair and impartial, is pressed to take a partisan view. It is very essential to lean toward neither extreme, but keep on neutral ground, and aim toward a course which represents justice to all concerned and a solution in the common interest.

In connection with the work of valuation there are problems now before us in the proper method of valuation to adopt, the question of depreciation and how to treat it, and the further matter of going value. All of these problems partake strongly of an economic nature and the engineer who would deal with them successfully should have a grasp of economics and should bring to the work a liberal attitude of mind. Next in importance come the questions of proper service standards for the different utilities, as applied to communities of varying size and character. Much important work along these lines has already been carried out, both by some of the public commissions and by independent engineers. The work of the Wisconsin commission, in particular, is widely spoken of and frequently quoted. Wisconsin, in general, has been a pioneer State in the enactment of legislation for the public welfare, and in civic progress as a whole; the faculty and the instruction staff of the State University have there played a very prominent part in the work.

On the industrial side, also, there is the vital necessity of safeguarding workmen from accident and occupational diseases. It is coming to be axiomatic that each industry ought to bear the burden of its own accidents and disasters, rather than leave these to be borne by the workers. This seems to be just and equitable and puts the burden of risk to life and limb where it properly belongs. The casualties which occur are properly a part of the cost of production, and the burden ultimately falls on the consumer, whether he pays for it in the shape of an extra increment in the price of commodities, to cover the workers' insurance, or whether he contributes his quota to support incapacitated workers who become public charges. The essential point is that the first plan protects the worker and distributes the burden equitably, while the second often falls heavily on the worker himself and is clearly inequitable.

The engineer meets this question on the side of designing and devising protection for workmen from the risks of their occupations, for when the employer becomes fully liable to the employee, it is clearly economy to reduce some of the risks that hitherto have been suffered to exist. This applies to a great many industries, and of course to many parts of the electrical industry. Industrial development in this country has gone ahead so rapidly that we have often used rough and ready methods and paid little heed to the cost of our progress in terms of human suffering or the loss of life. That we are about to remedy our errors in this direction is apparent in modern laws designed to protect and insure industrial workmen and in the more liberal attitude of the progressive corporations.

The new art of city planning, under which we are endeavoring to beautify our cities, to reduce congestion and overcrowding, provide plenty of pure air, light and sunshine, and in short to build a model community in which all things harmonize—here also the engineer finds a very useful field of activity, wherein the spirit of co-operation with the architect and the municipal expert is most imperative. The part which the engineer should play here is largely hidden from view, consisting of the fundamental engineering which underlies all properly executed structural works, and appeals so little to the layman as he looks upon the final result. The architect is naturally the most prominent factor in plans for the city beautiful, but beauty alone is not the proper end. Unless at the same time we can release the overcrowding of tenements, provide ample play grounds and parks, care for the street traffic, arrange efficient transportation, light the streets properly, and in every way provide for the public health, safety and convenience, then city planning has little to commend it.

In all this work of civic progress and betterment, relating to conservation, utility regulation, protection of industrial workers, conserving the public health, and city planning, the engineer is necessarily a prominent and invaluable factor. He owes a direct duty as a citizen, and an extra duty as a professional man, to lend his aid toward a proper solution of all these questions. As time goes on, the value of engineers' services in these matters will be more widely appreciated, but meanwhile it is fitting that engineers themselves should come forward and contribute their share toward the welfare of society.

The Rate Research Committee of 1911 of the National Electric Light Association held its first meeting on November 10th at the office of the Cleveland member, S. E. Doane. Those present included E. W. Lloyd, chairman; L. H. Conklin, S. E. Doane, R. S. Hale, H. R. Lyons, R. B. Norton. After spending the day in discussing its work and plans, the committee adjourned to meet again in New York City on December 8th. The report of the Rate Research Committee of 1910 is now available. The published volume is being mailed to the members of the National Electric Light Association, and is worthy of their serious study.

The Nature of the Southern Industrial Plant and its Electrical Equipment.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY H. P. WOOD, B. S., E. E.

THE Southern industrial plant does not necessarily differ from the plant for similar work in other sections of the United States. The choice of motive power however, may be more complicated in the South than elsewhere, for we often have within reasonable distances, abundant supplies of coal, wood or oil for steam or gas generation, and also water power. Furthermore, since the radius of electrical distribution has been extended to two hundred miles, energy from our water powers may be delivered at many points with economy and reliability.

The mineral and agricultural products of the South are abundant and varied in character, and not many years ago these were shipped to other points for manufacture. Coincident with the rise in applications of electrical power to manufacturing there has been an industrial awakening in the South which promises to reach great proportions. As an instance of this the Census reports show an increase in the power applied to cotton mills in the United States for the five years from 1900 to 1905 of twenty-eight per cent. For the same period the increase in North Carolina was sixty per cent and in South Carolina and Georgia, one hundred per cent. At the present time about forty per cent of the mills in the Southern States are electrically equipped.

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The magnitude of the power requirements of the industries of the United States is not always appreciated. The following deductions for the year 1910 are obtained from Census reports and elsewhere:—

Power used in manufactures	17,000,000 H.P.
Power used by steam railways	5,000,000 H.P.
Power used in mines, quarries, etc	4,000,000 H.P.
Power used by electric railways	3,500,000 H.P.
Power used in electric lighting	3,500,000 H.P.
Total mechanical horsepower	33,000,000 H.P.
Power produced by steam	28,000,000 H.P.
Power produced by water	3,500,000 H.P.
Power produced by gas and oil engines	1,500,000 H.P.

The quantity and diversification of raw materials is so great in the South that it can scarcely be hoped to manufacture all of them into finished products. Mr. George Westinghouse in his remarkable address before the Southern Commercial Congress said: "The industries most likely to be developed and to increase because of peculiar suitability to conditions now existing in the South are: Textile mills, fertilizer works, cement plants, coal, iron, copper and gold mining, ore reduction plants, iron and steel mills, agricultural implement works, canning factories, road building, furniture manufacture, lumber plants, paper mills, shoe and leather factories, and oil refineries, in all of which industries electric power increases production." The electric motor does not necessarily make possible an industry nor in factory work does it always save power, although it is possible to keep the losses in a textile mill with direct drive down to twenty per cent. If instead, however, an electrical generator be operated at an efficiency of ninety per cent and electric motors at efficiencies of eighty-five per cent, we come out with a combined efficiency of only seventy-six and one-half per cent; a figure not so good as that obtained by the assumed direct drive. The flexibility of the electric drive may more than make up for loss in efficiency, however, in the eyes of the industrial engineer. For with electric drive a part of the mill may be run if it falls behind the rest, without running the whole mill and in many classes of work this is a decided advantage. There is also a partial or complete absence of light obstructing belts which is conducive to more rapid and accurate work by the operatives and greatly adds to their comfort and health. The motor drive, moreover, may be made to fit any mill. With direct drive it is necessary to build the mill to fit the jack-shafts, idle pulleys and multiplicity of belting, which had to be laid out in many cases when the building plans were drawn.

In deciding whether to use central station power or to erect a plant, the mill-owner has a problem, the logical solution of which may involve engineering of the highest order. In lumbering or coal-mining operations the solution is simplified for his location is essentially determined. Likewise his fuel is either scrap wood and sawdust, in the one case or coal in the other. In either case the cost of the fuel may be a small item, yet the more efficiently he generates and utilizes the power, the lower will be the labor cost in the boiler room and the smaller will be the boiler plant which must be installed.

If central station power is used it must be done by the use of electricity as no other system of transmitting power for any distance is feasible. Other systems have been in use in Europe. At Schaffhausen in Switzerland, energy from the Falls of the Rhine was for a long time transmitted by a complicated and extensive system of cables, running upon sheaves on towers. In Paris a system of distributing power by the use of compressed air and compressed air engines was employed for many years. In London a high pressure water system is used, particularly for work along the docks to assist in loading and unloading vessels. These three systems are giving way in turn to the electric system and none of them has ever come into extended use in this country, except at mines.

If the electrical energy for the factory drive is adopted, it is well to investigate carefully before deciding upon the type of equipment. Even if it is decided to install a separate plant, the motor drive should be selected so that central station power could be connected to it at some future time, without the necessity of some system of conversion. The standard supply to large factories in the south might be said to be 2,300 volts, three-phase alternating current. A lower voltage may be readily obtained but the three-phase, 60 cycle circuit is almost always used. Two-phase currents may be obtained from any three-phase circuit without the use of any rotating apparatus for converting it. The frequency of alternation of 60 cycles per second cannot be readily changed, as to do it a rotating frequency converter must be used. Some large plants in the South still use 40-cycle current and others use 25-cycle currents.

There is a decided opinion that all large water-power stations should adopt some standard of voltage, frequency and phase in order to facilitate the possibility of tying together and forming a huge network over the whole country. This policy may insure against interruption due to low water as the diversification of stream flow is such that high and low water do not always occur in different watersheds at the same time and this is especially true in the South where normal stream flow is small. The reliability of power supplied by the so-called hydro-electric companies is unquestioned, as steam and gas engine reserve stations are kept ready for instant use in case of interruption due to low water or any other cause.

For all ordinary operations requiring constant speed the polyphase induction motor is particularly satisfactory. Likewise it is eminently suitable for rough, temporary work around mines, quarries and large construction work. The contractors in doing the work at Ninety-nine Islands plant of the Southern Power Company, used an average of one thousand kilowatts for supplying induction motors driving rock crushers, concrete mixers and other machinery. The same arrangement is being used on the construction work of the Columbus Power Company's development at Goat Rock, Ga., at the present time. This energy was taken from the nearest transmission line of the Southern Power Company in the first case and from the Columbus plant at Columbus, Ga., in the other and is an example of an application of electric power which has as yet scarcely started in the South. In the cities the electric motor can replace most of the small engines and boilers which are being used in construction work.

It is essential that the voltage for induction motors be kept up to the normal amount. This is most satisfactorily accomplished by using rather high rated values. A rough rule to follow is to keep the current in alternating circuits less than one hundred amperes. Higher values may cause excessive drop in voltage due to the greater proportional effect of the line reactance. The practice of running all circuits in iron conduit is growing in favor. The wires running to any motor are necessarily kept in the same conduit and as the outgoing and return currents are equal at any instant, the magnetizing effect of the currents is neutralized so that the reactance drop of the circuit becomes negligibly small and the hundred ampere rule mentioned above may be disregarded.

A low power factor is unavoidable if the induction motor is lightly loaded. The average power factor of a well designed layout of induction motors in cotton mills is usually less than seventy per cent. This means that when the motor is giving out seventy horsepower, it is also taking in seventy horsepower more for an instant and giving this amount back to the generator the next instant. In other words when there is seventy useful horsepower there is also seventy horsepower which is surging back and forth in the circuit, which causes unnecessary losses in the transmission and generating apparatus. This power which is swashing back and forth in the circuit is properly turned reactive power. The condition is somewhat analogous to that which obtains when, if we wish to deliver to a power plant seventy tons of coal each day, we deliver one hundred forty tons and haul back seventy tons.

So serious is the effect of low power factor upon the regulation and capacity of the generating plant that it must be remedied. This is accomplished in one large textile mill by using a synchronous motor to raise the power factor by its well known property of drawing a leading current with over-excited fields. When properly adjusted the synchronous motor returns its reactive power at the same instant that the induction motor demands it. Thus the only power coming in over the line is that which is useful.

A synchronous motor used in this way constitutes what is termed a synchronous condenser and gives the greatest sum of useful and reactive power components when each is seventy-one per cent of its rated capacity. At some mills synchronous apparatus has been installed to raise the power factor of the load drawn from a water power plant in order to secure better rates for energy. Synchronous apparatus used in connection with induction motors is essentially a help to the generating station and its increased use in some form is assured.

Where control of the speed is necessary, the direct current motor is more desirable than the alternating current motor. The interpole motor for direct currents seems to accomplish everything that was accomplished by the multi-voltage systems and may replace them. Speed control of an interpole motor by changing the field current is simpler than in the multi-voltage system and the complexity of the wiring is reduced. Coal cutting machines and mine locomotives use the direct current motor exclusively. It might be mentioned, however, that some mine locomotives using polyphase motors have been installed in a coal mine in Illinois.

Some classes of machine shops and printing establishments also need direct current motors on account of the necessity of controlling the speed. In most other work the

induction motor will give equally good service. The only methods for obtaining direct currents for industrial uses from alternating current systems are by the use of rotary converters or of motor-generators. Either piece of apparatus necessarily adds to the first cost of an installation and reduces the efficiency to such an extent that conversion is not carried out unless absolutetly necessary.

Electric motors are finding a broad field of application for pumping water from mines and for driving pumps in connection with municipal water supply systems. They are extensively employed in West Virginia for pumping oil and for operating the well driving machinery in the oil fields. Motors are used in large numbers at fertilizer works, the fertilizer businees being unusually large in the South. They are used for the ginning of cotton and for the operation of the cotton seed oil plants. This industry commences in September and continues for some months. A number of large lumber mills use electric drive, a lumber mill at Bogalusa, Louisiana, is equipped with induction motors aggregating one thousand horepower.

Much interesting and specific information in regard to the use of electrical energy in textile mills is given in an article by Mr. George K. Hutchins in the November, 1911, issue of the SOUTHERN ELECTRICIAN. He gives a detailed statement of the electrical equipment in five different cotton mills, and the most striking feature is the growing use of the synchronous motor for group drive. He also shows by his figures, "First, that the electric drive is fast growing into popularity with the textile industry, for the requirements of which it is pre-eminently fitted, and second, that the tendency is toward the growing use of smaller units."

Electric lights are used whenever current is available in all of the industrial establishments of the country. The tendency istoward the increased use of the tungsten lamp and of efficient reflectors. The mercury vapor lamp is also favored in many cases as in spite of its peculiarities, colors can be accurately matched in textile mills. Arc lamps are still in use in large, open shops and for lighting yards and grounds.

An interesting application of electrical energy other than for power or for lighting and one which promises much development in the future is in the manufacture of nitrogen compounds in the electric furnace. The Southern Power Company will furnish energy to the extent of five thousand kilowatts to a plant which is being built in South Carolina for the electrical fixation of atmospheric nitrogen. When we remember the wonderful group of electrochemical industries which has sprung up at Niagara Falls because of its abundant electric power, we are justified in looking for some similar development to occur in the South.

The power plant for driving the machinery is such an important part of the factory as to be worthy of extended consideration. It would appear that unless steam is needed for heating or other purposes in the factory, water power should always be the prime-mover. Unfortunately this is not always the cheaper. Furthermore, hydro-electric energy is not always available and some mills are compelled to continue the use of existing steam power plants and increase their efficiency of operation if possible.

Where simple engines have been in use, the installation of exhaust steam turbines and condensers has enabled more power to be obtained with no increase in fuel consumption. This increased power may most readily be obtained in electrical form, as steam turbines are better adapted to direct connection to electrical generators than to direct drive by the use of ropes, belts or any other form of mechanical connection to the mill shafting. Condensing water must be available for these turbines and cooling towers are commonly used to keep down the consumption of water. Exhaust steam turbines have in this way been installed at the plant of the Atlanta Steel Company, at Atlanta. The economy derived from their use has not yet been published.

In many industrial plants of good size where electric drive is used, the steam turbine rather than the reciprocating engine is installed. The generator is usually three-phase and the voltage depends upon the extent of the plant and the size of motors. Where a plant wishes to economize on first cost and expects to extend its equipment in a few years, a simple Corliss type of engine without a condenser is good practice, arranged for the addition of an exhaust steam turbine and condensers when the extensions are made. The LeBlanc condenser secures such a high vacuum with simple apparatus that this type is quite popular at present.

Condensing or high efficiency plants may not be installed if exhaust steam can be used for heating and for other purposes in the factory. However, in the South, the ordinary heating requirements of buildings for bodily comfort are not so serious as in the North. Also in buildings where much power is used, the fact must not be lost sight of that the entire energy of the plant is ultimately dissipated as heat in the various machines or materials. Certain electro-chemical processes are the only exception to this. This means that the plant will give as much heat by the utilization of its power as can be obtained by the burning of probably one-fifth as much coal in a direct heating system.

Our cotton mills have adhered quite closely to white goods manufacture. Colored goods require more heat for dyeing and their manufacture may be best adapted to steam driven plants.

A type of plant for industrial drive which is coming into use is the gas engine operating from producer gas. The producer is supplied with bituminous coal, lignite, anthracite or wood, and power is produced by these plants with one-half the fuel that is required by the best type of steam driven plant. A textile mill at Union Point, Ga., is driven by two gas engines using producer gas. One is belted to a main group drive and the other connected to a generator and drives a part of the mill with electric motors. At other points there are oil-mills, dredges, electric railways and electric lighting plants driven exclusively by gas engines using producer gas.

Somewhat to the surprise of American visitors, electric vehicles are used successfully for taxicabs in Berlin. These now number some three hundred, and were first introduced in 1899. With time and hard usage, a type specially suited to this service has been developed. The most frequently seen is the so-called N. A. G. car, made by the Neuer Automobile Gesellschaft. These vehicles are rated at forty-horsepower and forty-four cell storage batteries are employed which can be charged in five hours. Their speed is thirty kilometers per hour while the mileage is from a hundred to a hundred and twenty kilometers on a single charge.

Southern Development and the Agencies Shaping Electrical Future of the South.

(*Written for* SOUTHERN ELECTRICIAN.)

BY D. H. BRAYMER.

WHEN the casual engineering reader, either through curiosity or from real interest, stops to review in his mind the electrical development of any section, there is usually a confusion of dates and other data, with few reliable sources on such material at hand. It is the purpose of the writer therefore to present in as few words as possible, a summation of the past and proposed developments in Southern territory, not with a view of showing up the engineering features involved, but to record in one place the available data on these developments and present a brief sketch of the engineering and financial agencies that have been responsible for the work as it now stands.

On account of space limitations in this issue, and on account of the fact that details of various developments appear in other sections, we will confine ourselves to the larger and more important of the present and future developments. Any review of this nature necessarily presupposes a brief sketch of the pioneer work and in this regard we are particularly fortunate in being able to go back only 17 years and trace such activities through the first and up to the present time, the largest operating electrical system south of the Mason and Dixon Line. It is interesting to note that the first high voltage generator operated in America was installed near Anderson, S. C., in 1898. It is also worthy of mention that the first electrical transmission in the South was at Anderson, S. C., in 1895 when 175 horsepower was transmitted from the Rocky River to Anderson, a distance of eight miles at 5,500 volts. The voltage used at Anderson in 1898 was 11,000 volts, the generators delivering this voltage direct to the lines which transmitted 1,200 K. W. from Portman Shoals to Anderson, a distance of ten miles. Twenty-eight years earlier Gramme produced his first dynamo (1870), and in 1878 Edison exhibited his first incandescent lamp. The telephone also appeared at this time, an invention which has done much for long distance transmission.

A casual glance over records giving earliest history of electric transmission, shows the activity in the South at the front, for we have no less authority than Mr. J. W. Fraser, Assistant Chief Engineer of the Southern Power Company, for the statement that the first electrical transmission in America was installed at Telluride, Colorado, in the summer of 1890. A 100 horsepower single phase generator supplied power at 3,000 volts over a line two miles in length to a 100 horespower synchronous motor. In 1903 the first polyphase transmission system was put into service at Redlands, California. This line was three phase, 2,500 volts, eight miles in length. The decision in the same year to make the generators at Niagara Falls polyphase, instead of direct current, marks an epoch in transmission history. The Folsom-Sacramento Plant in California, the first polyphase transmission at 10,000 volts was put into operation in 1895. It will thus be seen that the operation of this plant and the one at Anderson in 1898, while separated a distance from coast to coast, arrived at practical development very nearly at the same time.

The next step in the South was to increase the size of development and we have the organization of the Catawba Power Co. as one of the pioneers to bring this about. A 10,000 horsepower plant was commenced in 1900 on the Catawba River near Rockhill and completed in the spring of 1904. Credit for the origination of this development must be given to Dr. W. Gill Wylie, born in Chester, S. C., and now of New York, who started the work on the dam near Rockhill in 1900. Several contractors attempted the concrete work in connection with this development but they were not accustomed to handling river conditions such as obtained on the Catawba and it was not until Dr. Wylie secured the services of Mr. W. S. Lee that the work progressed in anything like a satisfactory manner. Mr. Lee completed the dam during the latter part of 1903 and the Victoria Mills at Rockhill were taken on as a load about March, 1904.

While this date marks the sale of hydro-electric power in large quantities to textile mills in the South, it must be remembered that the first textile mill in the world, to be equipped throughout with electric drive, was the Columbia Cotton Mill at South Carolina, which connected to a hydro-electric plant in June 27th, 1894. At first, although the reliability, convenience, and economy of electric drives had been demonstrated in several instances, the attitude of the mill man was that of distrust. That this feeling has been entirely reversed, I have only to state that fifteen years' growth of hydro-electric plants in the Piedmont region, has given the Southern Power Company a plant capacity of over 200,000 horsepower and developments nearing completion of approximately the same amount, while the total horsepower of projected plants, reaches these two amounts put to gether.

Considering again the early developments, it may be well to give a few of the physical and electrical characteristics of the various plants, showing the development and the growth. At the plant on the Catawba River put into operation in 1904, 13,000 volt generators were used directly on the transmission lines to Rockhill, six miles, to Charlotte, eighteen miles, and to Clover, 23 miles. In 1905 the Southern Power Company was organized for the purpose of taking over the above plant and developing certain water powers on the Catawba and Broad Rivers. The transmission line to Charlotte was built in the autumn of 1904 and to Yorkville and Clover in the spring of 1905. It was about this time that Dr. Wylie interested the Dukes in his project. The work of the company then progressed rapidly and the resulting plants were put into operation in the following order. The Great Falls development of 24,000 K. W. capacity with 200 miles of 50,000 volt lines was put into service in the early spring of 1907; Rocky Creek of the same capacity as Great Falls with as much

additional 50,000 volt lines was completed in the spring of 1909 and Ninety-nine Islands with a capacity of 18,000 K. W. was completed in the spring of 1910.

In the autumn of 1909 a 100,000 volt line of 250 miles was put into service and since that time a second circuit has been strung on these towers and a 140 additional miles of two circuit 100,000 volt lines completed, a total of 1,380 miles of three phase transmission lines. Simultaneously with the growth of lines there was built twenty-five 10,000 volt, thirty-two 50,000 volt, and eighteen 100,000 volt substations ranging in size from 300 to 28,000 K. W. and secondary voltage of 550, 2,200, 11,000 and 44,000. Within the last year two 8,000 K. V. A. auxiliary steam turbine stations have been added to the generating plant and one 2,600 K. W. hydro-electric station purchased.

To the reader unfamiliar with the conditions in the South, it may be altogether logical for him to ask at this point where and for what purposes the immense amount of power represented by the above plants can be used. The answer is that a greater part of this power is used by cotton mills of various sizes, to the number of 156, the remaining power supplying six street car systems and the lighting and power loads of 45 towns and villages. Further as an indication of the field yet uncovered, it is well to state that there are in the South cotton mills alone operating 13,000,000 spindles and using approximately 450,000 horsepower. Only about 40 per cent of these plants are now operated electrically by central station or by their own electrical power plant, thus leaving 60 per cent of the mills as a possible load.

The accompanying map of the transmission system of the Southern Power Company shows how scattered the market is. Taking Charlotte as a center, mill villages and towns of all sizes varying from 1,000 to 30,000 inhabitants, extend all along the Southern Railway, northeasterly to Durham and southwesterly to Greenville. The transmission lines shown in the map give a good idea of how the Southern Power Company handles their load from the various plants above mentioned.

It would not be altogether justifiable for us to leave this brief description of the Southern Power Company's developments without considering the personality which backed up the planning and successfully developed the engineering schemes born in the minds of those who today make up the executive and engineering boards of the South's pride in the electrical field. One of the pioneers in the water power development in the section served by the Southern Power Company and one in a measure responsible for the organization of the now Southern Power Company, was W. C. Whitner, formally of Rockhill, S. C., a constructing engineer of note and ability. Mr. Whitner was interested in developing water powers upon the Catawba River and while in New York met Dr. W. Gill Wylie, whom we have mentioned above as a native of Chester, S. C., and an eminent surgeon. Dr. Wylie had previously invested in the Anderson Water Light & Power Co., and this meeting proved at once a fruitful one in as far as future developments were concerned. Mr. Whitner in 1901 resigned his connection with the Catawba Power Co., and was succeeded by Mr. W. S. Lee, who is now well known as the giant electrical genius of the South. The credit of the first development already mentioned is entirely due to his superintendance and direction as well as a majority of the original ideas which the company thereafter followed. It was he who had mapped out and completely developed in his mind the work of developing the water powers in the Piedmont Section and who upon unfolding his schemes to Mr. J. B. Duke, himself a North Carolinian, immediately convinced this man of millions, already interested in Southern development that the gigantic plans for hydro-electric development as explained, were not those of fancy, but based on real engineering. The successful development of the whole list of activities covering the past fifteen years, is due therefore, to the unlimited capital and remarkable business ability of Mr. Duke on the one hand and the combination of engineering ability and keen business sense on the part of Mr. W. S. Lee on the other hand. The efforts of these two men have enabled the company to not only design, construct and operate its plants but also to develop them to the fullest commercial efficiency and put them on a firm business basis.

Mr. Williams States Lee was born in 1872 in Lancaster, S. C. He received his early education in common schools, his technical education at the South Carolina Military Academy, graduating in 1894. After graduation he taught in the graded schools of Anderson, later taking up engineering work and becoming resident engineer of the

W. S. LEE, VICE-PRESIDENT AND CHIEF ENGINEER, SOUTHERN POWER COMPANY.

Pickens Railway Company, subsequently resident engineer of the Anderson Water Light & Power Co., when he had charge of the construction of the Portmans Shoals Hydro-Electric Plant on the Seneca River, where he installed the first 10,000 volt generator put in service in America. After completing this plant Mr. Lee spent some time on construction work in connection with the United States Government coast defense plans for the Charleston harbor. In October, 1898, he became a resident engineer of the Columbus Power Co., which company was constructing a dam on the Chattahoochee River at Columbus. This dam although completed in 1900, was swept away by flood and the reconstruction of the dam, together with transmission lines, substations, etc., placed under the direction and supervision

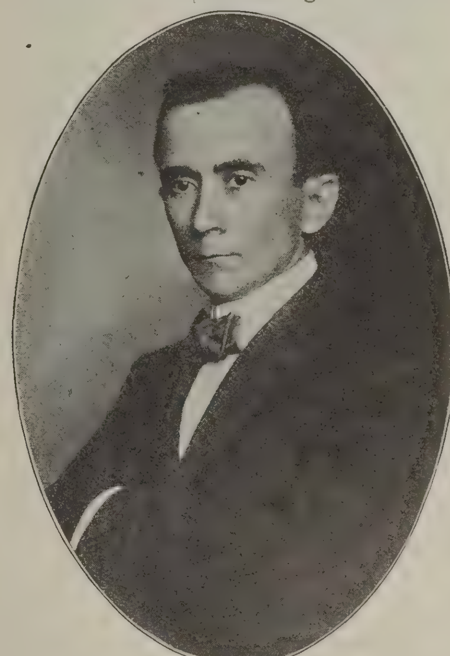
of Mr. Lee as chief engineer for the company. He modified the design and raised the height of the dam, completing it in the spring of 1902. This was the first large dam built in the South and constructetd under most unfavorable conditions due to quickly rising floods.

J. B. DUKE, PRESIDENT SOUTHERN POWER COMPANY.

After completing the hydraulic and electrical installations at Columbus, Mr. Lee accepted a position as chief engineer for the Catawba Power Co., which company was building a dam at India Hook Shoals near Rockhill, S. C., on the Catawba River. It was at this point and on this work that three contractors failed as mentioned above, in the undertaking and it fell to Mr. Lee to construct the dam which he did, completing it in the spring of 1904, together with transmission lines to Rockshill and Charlotte. Upon the formation of the Southern Power Co., which took over the Catawba Power Co., and purchased larger power rights on the Catawba and Broad Rivers, Mr. Lee was made chief engineer and in addition acted in the executive capacity of second vice-president. This position he now holds. Mr. Lee is a man with excellent judgment, indefatigable perseverance and of great personal magnetism.

In the early stages of the developments mentioned Mr. Lee was decidedly fortunate in securing the assistance of two other engineers who have, through their work under him, also secured for themselves a name and considerable prominence as engineers. These men are Mr. J. W. Fraser, who has had charge of the electrical details of the various power developments with the title of assistant chief engineer, and Mr. C. A. Mees, who has had charge of the hydraulic details. Mr. Fraser is a Canadian by birth, born in Bridgeville, Nova Scotia, March 6th, 1874. After receiving his education in common and high schools and at Pictou Academy, at Pictou, Nova Scotia, he entered McGill University, Montreal, where he received the degrees of B. S. and M. S. Later he entered the employ of the Westinghouse Electric & Mfg. Co., where after spending sometime in the various manufacturing and testing departments, he was transferred to the erecting department and later accepted a position with Shawinigan Water & Power Co., of Montreal, with which company he acted as constructing engineer. After the Shawinigan transmission line and the plant was operating successfully, Mr. Fraser returned to the Westinghouse Electric & Mfg. Co., as constructing engineer, in the autmn of 1905.

He was shortly sent South to take charge of the erection of power plants and large motor installations principally in textile mills. His work there took him from North Carolina to Alabama, giving him a varied experience in the costs of construction, the managing of labor and economy of design. At about this time the Southern Power Company was being organized to take over the Catawba Power Company in South Carolina, whose plant was near Rock Hill, and develop all the water power on the Catawba River. Mr. Fraser, on account of his experience, was selected as assistant chief engineer in charge of all electrical design and construction. He has since filled the position in its broadest sense, in that he is entrusted with the design and supervision of construction and is identified with the purchasing of all the apparatus and construction material for this system. Mr. Fraser's work has gained for him a broad



J. W. FRASER, ASSISTANT CHIEF ENGINEER SOUTHERN POWER COMPANY.

knowledge of standard apparatus and specifications and of purchasing to the best advantage in its broadest sense.

Mr. Fraser must be accorded the honor of being a pioneer in 100,000 volt transmission for although one short line was in operation when the Southern Power Company's lines were designed, it remained for Mr. Fraser to put into service a system that could be controlled with the same ease as a 10,000 volt system and to put into service outdoor types of circuit breakers and substations. He has contributed numerous articles to the technical press and papers and discussions to the A. I. E. E.

Mr. C. A. Mees was born at Columbus, Ohio, September 16, 1877. He entered Rose Polytechnic Institute in 1896, and since graduation has held the following positions: Assistant on the Engineering Corps of the E. & A. Division, Pennsylvania lines west of Pittsburg, June, 1900, to March, 1902; assistant in the office of design, New York

Central Hudson River Railroad, March, 1902, to Sept., 1902; assistant engineer of the Catawba Power Company, Rock Hill, S. C., September, 1902, to May, 1904; special personal work, May, 1904, to August, 1904; resident engineer, Board of Public Service, Columbus, Ohio, August, 1904, to December, 1904; draftsman, department of design, Board of Public Service, Columbus, Ohio, December, 1904, to April, 1905. Since April, 1905, he has been designing engineer for Southern Power Company, Charlotte, N. C. Mr. Mees is associated with the following engineering societies: M. Am. Soc. C. E., Assoc. A. S. M. E., Assoc. A. I. E. E., Mem. Eng. Assoc. of South, M. Am. Soc. Eng. Contractors. He has contributed to the technical press much valuable, original material.

C. A. MEES, DESIGNING ENGINEER, SOUTHERN POWER CO.

Since being connected with the Southern Power Company, Mr. Mees has designed the following structures: The Great Falls Station, 24,000 K. W. generator capacity; the Rocky Creek Station, 24,000 K. W. generator capacity; the Ninety Nine Islands Station, 18,000 K. W. generator capacity, and all the auxiliary structures, such as substations, transformer houses, etc., for about 1,500 miles of primary high tension transmission lines, 11,000, 50,000, 100,000 volts.

The Interurban Trolley System.

Since the moment the Southern Power Company was organized to this date of present achievement, there has never been a turning back point in the progress. Every accomplishment has led to a greater one. The joining of cities, towns, and villages by means of transmissioin lines has now been accomplished and the promoters backed by the advice of their ever-moving spirit, Mr. W. S. Lee, have undertaken to link towns, and cities in the two Carolinas with a system of interurban freight and passenger lines incomparable in construction with any now in operation in this country. In the development of the Southern Power Company and its affiliated interests, far sighted men have noted the great effects that good transportation facilities would have on this section, for it is a known fact that public utilities and railways have been the principle factors in the development of any section of this country. From a brief survey of the map showing the territory covered by transmission systems of the Southern Power Company, it will be easily observed that that company offers available power for railway use over a section of country approximately 350 miles long and 200 miles wide. Over this entire section, the stations of the power company can supply power within distances usually required for electric transportation. This in itself has heretofore given electric traction a handicap in this section and has brought to the minds of the financiers of the Southern Power Company as well as local manufacturers and financiers, the great possibilities of building a chain of electric railways throughout this section. This development has already been started and part of it is now being completed.

The plan of this development is exceedingly unique, in that it is built almost exclusively upon a co-operative plan. These roads are built by a syndicate composed of financiers interested in the power company and their friends and subscriptions from the various financiers and manufacturers along the line of road, the result being that this road will be built and put into operation without any bond issue at all on the same. Further when the road is completed and in operation, bonds can be issued and sold at a much more attractive rate of interest and price. This will reimburse the original investors to a large extent or will give them additional funds to proceed further with this great development. The co-operative features have further an attractive side, in that it will keep the good will of the people in the territory through which the railroad operates, as well as secure an enormous amount of their business. According to late information from an official of the Southern Power Company, it is expected to operate cars on part of the interurban by the first of 1912. Shortly after this the plant for making nitrate now under construction at Great Falls will also be put into operation.

In the developments of the Southern Power Company and its affiliated interest, which includes public utilities and railroads, Mr. J. B. Duke stands out pre-eminent as a great factor both as to brains and finances. Mr. Duke is naturally a developer and not a promoter. He is a man who is always well pleased to see any section developed and his record has always been to support any undertaking which he has been interested in and carry it to a successful conclusion. It matters not what business he has ever entered, his idea and slogan has always been "Give the best service possible for the least money." In entering the field of power transmission he has set new standards for service. He is particularly interested in the Piedmont section, this being his old home and he has done a great many things to help the development of this section, which should be credited to him that in general is not.

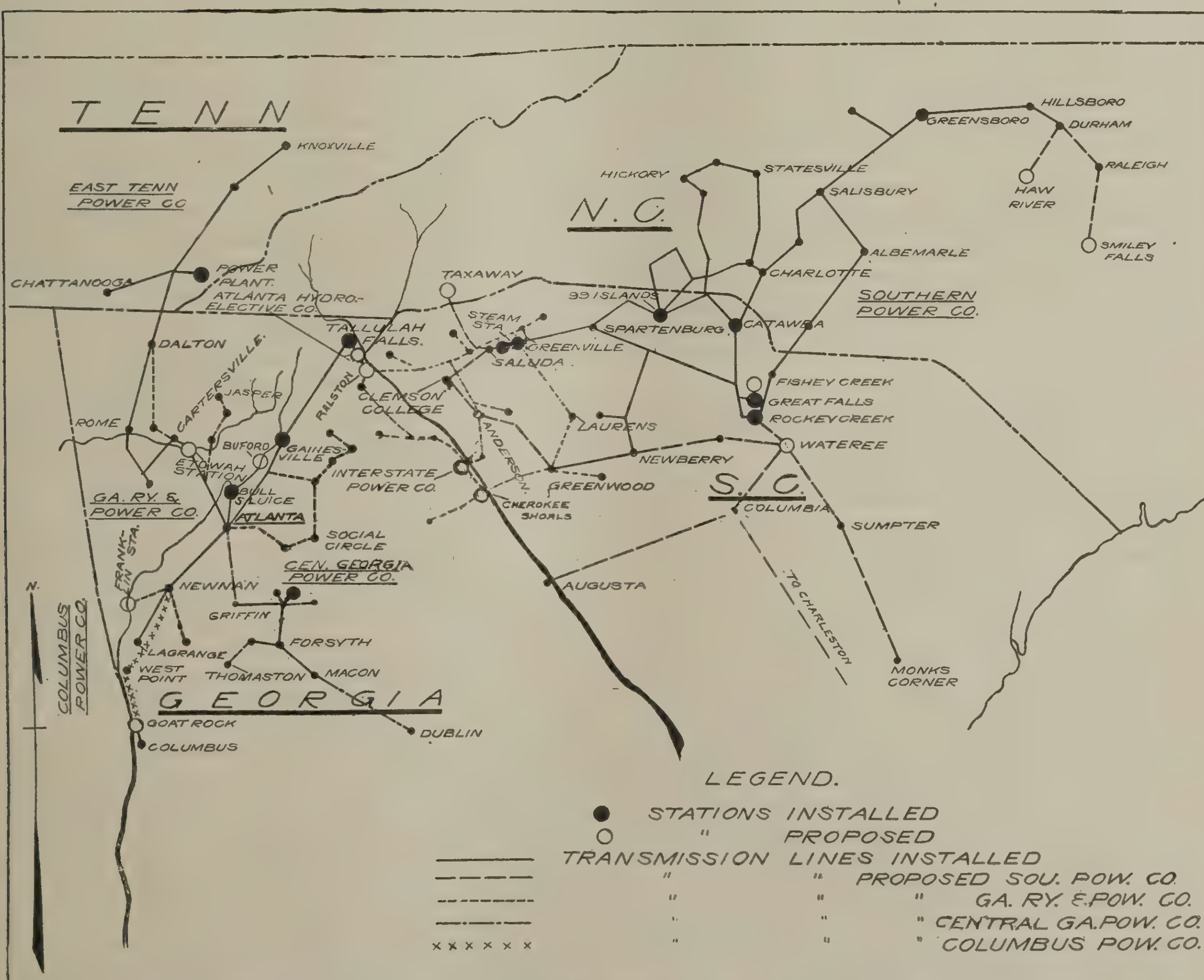
Electrical Developments Recently Completed or Under Way.

While we have just reviewed the largest developed and operating system in the South, we will now consider the largest proposed system. There has been organized during the past few months a new company known as the Georgia Railway & Power Company, backed by Canadian and English capitalists and having plans to absorb hydro-electric

development projects in Northern Georgia and to take over by a lease arrangement and operate in connection with its other activities, electric street railway, electric lighting, heating and power companies now controlled by the Georgia Railway & Electric Company of Atlanta. Among the water power developments to be consolidated under the new Georgia Railway & Power Company are the power plants at Bull Sluice, the Etowah Power Plant and the Talullah Power development now in course of completion. This corporation is modeled after the Southern Power Company and has among its immediate plans for the future, the construction of an electric line to Stone Mountain, to connect with the lines of the Georgia Railway & Electric Co., at Decatur, and thus establish communication with Marietta, East Point, College Park and other suburbs.

As the plans now stand the company proposes to develop electric power, operate street railways and furnish light and power to municipalities and private corporations. It will have as competitors the Southern Power Company, operating in South Carolina close to the Georgia line, and the Eastern Tennessee Power Company, The Chattanooga and Tennessee River Power Co., the Central Georgia Power Company, and the Columbus Power Company. Through its system of transmission lines, it will furnish power to the cities in Northern Georgia and Eastern Tennessee, including on the east, Elberton, Hartwell, Toccoa, and Clarksville, on the west, LaGrange and Carrolton, on the north, Rome, Dalton and the marble quarry section about Canton and Jasper, on the south, Social Circle and Covington. These points indicate the boundary of the territory planned to serve, while the intermediate cities and towns will be connected to the transmission system running near them.

In addition to the three water powers already developed and in course of completion, mentioned above, the company owns several other projects which will be developed as the necessity arises. Among these are the water power sites on the Chattahoochee River, between the North Georgia Electric Company's development at Gainesville and West Point, Ga., including the Franklin Shoals property in Heard County, Georgia, and sites on the Savannah and Etowah rivers. The completed system will include ten developments with a total horsepower of 350,000. The developments will be distributed as follows: One on the Etowah, four on the Chattahoochee, one at Tallulah, two on the Tugalo and two on the Savannah. Of these, two on the Chattahoochee are completed and in operation, the Bull Sluice and the Gainesville plants, while the development of the Tallulah Falls plant is well under way. The plans call for a generating capacity at Tallulah sufficient to supply 100,000 horsepower, which will be transmitted 90 miles to Atlanta over steel towers at a transmission voltage of



MAP OF HYDRO-ELECTRIC SYSTEMS IN THE SOUTH.

110,000. The company now plans to erect over 500 miles of transmission lines to serve the various sections above mentioned.

The prinicpal factors composing the executive organization are J. M. McWhinney, of Toronto, Canada; Charles Magee, R. Matthison and G. A. Kingston, of Toronto, and Forest Adair, J. J. Spaulding, A. C. King and E. Marvin Underwood, of Atlanta.

Development of Central Georgia Power Company, Jackson, Ga.

The first development on the Ocmulgee River is now in operation near Jackson, Ga. This development was undertaken in the spring of 1908 and water was turned on the wheels of the power plant in January, 1911. The personality behind the promotion of this development includes: W. J. Massee, President of the Central Georgia Power Company; J. C. Moore, M. F. Hatcher, J. C. Walker, and Charles F. Howe, of Macon, Georgia, and vicinity. It was financed by A. B. Leach and Company, of New York.

The development consists of a dam of Cyclopean concrete masonry 1,500 feet in length with 300 feet of embankment at the ends. The extreme height of the structure is 140 feet, the stillway being 120 feet high, producing a head at the wheels of 100 feet. The power house is built against the face of the dam and is a building 200 feet long designed for six main units of 3,000 K. V. A. each and two exciters. Only four of the units have as yet been installed. The energy is generated at 2,300 volts and transmitted at 66,000 about six miles from the dam over steel towers to Bibb, Georgia, where a switching station is located and from this point transmission lines laid in two circuits to Griffin, Forsyth, Barnesville and Macon, where it is stepped down in substations to 6,600 volts and distributed at this pressure. A transmission line is now under construction to Atlanta and one is proposed to Monticello, Georgia. The ultimate normal capacity of the development is 24,000 H. P. with the six units in operation. The entire development cost about $3,000,000. A description of this plant was published in the May, 1911, issue of SOUTHERN ELECTRICIAN.

The Development of the Eastern Tennessee Power Company Near Cleveland, Tennessee.

In February, 1911, an interesting hydro-electric development was started on the Ocoee River about sixteen miles from Cleveland, Tennessee, and near Parkville. The plant is now nearing completion and it is expected that the electrical energy generated will be delivered to Cleveland, Chattanooga, Knoxville, and other immediate cities in the surrounding territory as mentioned below. The initial installation of machinery provides for 21,600 H. P. with available space for another unit for 10,000 horsepower, making the total horsepower available for this development about 32,000. The company also controls a site about nine miles to the East where at some later date a second development of 60,000 horsepower will be constructed. The possibilities of the Ocoee River have been known for some time but no definite action toward actual accomplishments was undertaken until J. W. Adams of Chattanooga acquired the right a few years ago. Through the active efforts of Mr. Adams, E. W. Clark & Company, bankers of Philadelphia, were interested, Drexel & Company, bankers of Philadelphia, and Hodempyle Walbridge & Co., bankers of New York, resulting in the formation of a company known as the Eastern Tennessee Power Company.

The E. W. Clark & Company under the name of the Chattanooga Railway & Light Co., operates the street railway lines and lighting systems of Chattanooga and this company's steam power plant in that city will be used as an auxiliary to the water power plant. The Eastern Tennessee Power Company has taken over the electric light plant at Cleveland and increased its capacity to 1,000 horsepower to be used as an auxiliary to the water power plant for Cleveland and vicinity.

The dam in connection with the development will back up the water and form a lake about eight miles long and more than 2,000 acres in area. This will provide ample storage and a constant working head at the dam. The power will be transmitted as three-phase at 66,000 volts and stepped down for use to 2,300 and 4,400 volts, as desired. There is now being built 215 miles of transmission lines extending to Cleveland, Chattanooga, Athens, Sweetwater, London, Lenoir City and Knoxville in Tennessee and to Rome and Dalton in Georgia. On Big Creek at the head of the lake of the development now under construction, the second development will be located and this second lake will be formed by building the dam across the narrow gorge near Ducktown, including another lake of about 2,000 acres. Water from this lake will be carried by means of a tunnel through Big Frog Mountain, a flume and penstock, to the power house six miles below where a fall of 500 feet will be utilized, giving about 60,000 horsepower. The two plants together will develop about 85,000 horsepower. As a result of the ultimate completion of the company's undertaking, all of that part of the river for 16 miles from Ducktown and to Parktown will be utilized for power purposes. The organization of the Eastern Tennessee Power Company is as follows: C. M. Clark, president, G. L. Esterbrook, secretary and treasurer, and J. A. Cunningham, general superintendent.

Development of Chattanooga and Tennessee River Power Company at Hales Bar, Tennessee.

The construction work on the development of the Chattanooga and Tennessee River Power Company on the Tennessee River about thirteen miles from Chattanooga, is progressing rapidly under the direction of Jacobs and Davies Construction Co. Many difficulties have been encountered, in connection with work on this development, a large amount of the plant has been installed, some of which has been discarded and considerable damage and delay has been occasioned by floods. The development includes a dam and lock primarily intended to improve the navigation of about 35 miles of river channel above and a power house and transformer house for the ultimate development of 56,000 H. P. The construction work was commended in October, 1905, and it is expected that the plant will be finished during the coming year. The power house and transformer house is completed and ten, 4,000 H. P. turbines already installed. The ultimate installation will be fourteen driving 3,100 K. W. three-phase, 6,600 volt generators. Transmission voltage will be 44,000. A line 18 miles long and a 40,000 H. P. substation in Chattanooga is completed and power is expected early in the summer.

Each unit in the power house consists of three wheels

on a vertical shaft, the two lower wheels giving the full amount of power when the river is low and the head is high. As the river rises and its head decreases, the third wheel is put into service and the three wheels will then develop the power. The shafts are 94 feet in length and carry at their upper end the revolving parts of the three phase generators. Those in charge of the engineering work are as follows: Major William W. Hart, of the United States Corps of Engineers and G. H. Tisdale, Jr., in charge for the government and John Bogart, of New York, chief engineer, with Thomas E. Murray, Consulting Engineer, and George F. Powell, Resident Engineer, in charge for the power company. Charles J. Crowder is the superintending engineer for the Jacobs and Davies Contracting Co. B. T. Burt is general manager of the company.

Development of the Watauga Power Company Near Elizabethton, Tennessee.

The hydro-electric development on the Watauga River at Horseshoe about six miles above Elizabethton, Tenn., is nearing completion. It is the purpose of the developing company, the Watauga Power Company to transmit current 19 miles to Bristol on the Virginia, Tennessee State line, where it will be distributed to a general lighting and power service by a local company. It is also planned to furnish Elizabethton with power and if the capacity of the plant is not taken up by these two sources, a transmission line will be constructed to Johnson City, eight miles from Elizabethton. The ultimate normal capacity of plant will be about 4,800 H. P.

Work has been considerably delayed on this development on account of high water and to the cold weather of last winter. However, since the early part of the summer, work has progressed rapidly and it is now expected that the plant will be completetd at an early date. The three generators to be installed in the power plant are of 1,250 K. V. A. capacity, three phase, 60 cycle, 2,200 volts. The energy will be stepped up by transformers to 44,000 volts for transmission. The plans for the development were prepared by F. R. Weller, of Washington, D. C., and construction carried out under the direction of M. A. Weller, with Robt. L. Weide as resident engineer. The construction work was in charge of W. J. Oliver of Knoxville, Tenn. The officers of the Power Company are: Lee F. Miller, president; Walter E. Hunter, vice-president; and J. H. Grayson, secretary and general manager.

The Development of Yadkin River Power Company at Blewett Falls, N. C.

There is now under construction a hydro-electric plant at Blewett Falls, a few miles west of Rockingham which when completed will furnish 30,000 horsepower to the manufacturing industries in Rockingham and adjacent territory. The development consists of a concrete dam with a maximum height of 50 feet and a length of longest stillway between abutments of 1,219 feet. The natural reservoir made by the dam has an area of 2,500 acres. The unique feature in connection with this development is the natural formation of the ground so that the water can be diverted from the dam and carried around through a natural ravine to the power house which is located about 1,000 feet from the dam. The power house will be of the latest design, three stories high and have a handsome appearance. The energy will be transmitted over about 150 miles of double and single circuit steel tower transmission lines with a probability of 75 miles of subsidiary current lines making a distribution system of about 225 miles in length. The towers have been erected between Blewett Falls and Raleigh and other lines have been projected in the Southeastern direction to Laurinsburg, Pembroke, and Lumberton and also to McCall, Bennettsville, Dillon, Hammar, and west to Wadesboro.

Development of Columbus Power Company, Columbus, Ga.

At Goat Rock on the Chattahoochee River, twelve miles above Columbus, a development was started in the spring of 1910 and the plant is expected to go into operation in the summer of this year. The Columbus Power Company and Stone & Webster Company of Boston, Mass., are affiliated in the project, the former corporation being controlled by the latter. Stone & Webber Engineering Corporation are designing and constructing the plant as engineers for the Columbus Power Co., the local moving spirit in the latter company being Mr. John S. Bleecker. The representatives of the engineering corporation are J. L. Brown and G. F. Harley, while the Hardway Contracting Co., of Columbus, Ga., are contractors for the construction of the dam, power house, and sub-stations.

The development consists of a dam and power house integral with it. A reservoir of 1,000 acres will be formed by the dam which is 1,400 feet long, with a stillway 70 feet high. The extreme height of the power house section is 100 feet. The ultimate design of the plant calls for six main units of 5,000 K. W. each, and two exciter units. However, it is probable that not more than three main units will be installed in the first stage of the development. The power house is located on the Alabama side of the river and the ultimate capacity of its equipment will be 40,000 horsepower operating under the head of 68 feet. High tension transmission lines will be constructed to Columbus, West Point, LaGrange, Newman, and other cities in the territory with substations and distribution systems radiating from each.

The power machinery about the construction camp is operated by compressed air from a temporary motor-driven compressor plant making all operations most efficient. As power from the ultimate development is to be carried into Columbus, it seemed advisable to build the transmission line at the present time so that electricity for light and power would be available during the construction period. This line is about twelve miles long and three phase current at 11,000 volts is delivered at the construction camp. The energy is passed through a small substation, located on the Georgia side of the river and power is taken from the line for the three-phase motors driving the air compressors which furnish compressed air to drive all the apparatus except locomotives and steam shovels.

Development of the James White Power Company Near Athens, Ga.

A hydro-electric development has recently been completed at Barnet Shoals on the Oconee River, seven miles from Athens, Ga. The James White Power Company was incorporated in 1909 for the building of this hydro-electric development and actual construction was begun early in the year 1910. The plant was completed so that power was delivered in March, 1911. Electrical energy generated in this plant at 2,200 volts is transmitted

directly to the switchboards of the street railway company at its steam turbine station within the city limits, from this point being distributed as needed.

The development is the property of the James White Power Company of Athens, Ga., which company contracted early in 1910 with the Ambursen Hydro-Electric Construction Company, of Boston, Massachusetts, for both the design and the construction of the dam and power house. The dam is of the usual Ambursen cellular type, 920 feet in length and 62 feet above foundation at the highest point. The power house is part of the structure of the dam and is fitted for four units of 750 K. W. capacity each. All of the high tension apparatus is located above the operating floor on a gallery.

Improvements and Extensions to the Electric Light & Railway System of Augusta, Ga.

Improvements and extensions to the power house and electric light and railway systems of the Augusta-Aiken Railway & Electric Corporation are now under way. The extensions will consist in a turbine and boiler room to the present plant, in which will be installed a 60-cycle,2-phase, 2,750 kw., 2,300 volt horizontal Curtis turbo-generator, one 75 kw., 125 volt turbo-exciter and a 50 kw., 125 volt motor-driven exciter set. Turbines will operate condensing with a barometric ejector condenser. The boiler installation will consist of a battery of steel horizontal water tube boilers.

Additions and changes will be made to the Clearwater and Aiken substations. In the former will be installed a 500 kw. synchronous motor generating set, consisting of a 700 Kva., 2,300 volt motor, direct connected to a 500 kw., 6,600 volts direct current generators, with a direct connected exciter. Transformers and 100 kw. series booster direct coupled to a 500 kw. motor generator set together with a switchboard equipment will also be included. At the Aiken substation a 300 kw. synchronous motor generating set, consisting of a 430 Kva., 2,300 volt motor, direct connected to a 300 kw., 600 volt generator with direct connected exciter. Single phase, oil cooled transformers and a 50 kw. booster with the necessary switchboard equipment will also be installed in this substation. The transmission line will be constructed from the new station in Augusta to the Clearwater substation at Clearwater, S. C., a distance of seven miles.

The present lighting in the streets of Augusta will be replaced with ornamental steel poles, which will be arranged to carry the railway overhead network. Pay-as-you-enter cars will be installed on the railway system, which is also to be considerably improved. The J. G. White & Co., of New York has charge of the work as engineers.

The Engineering of Southern Developments.

The engineering talent responsible for the above developments as they stand at the present time, is representative of the best and most successful, both in hydraulic and electrical lines in this country. The engineering in connection with the electrical features and the construction of the Central Georgia Power Company's development was carried out after the plans of Lockwood, Greene & Co., of Boston, and J. G. White & Co., of New York. The former acted as consulting engineers, making all preliminary surveys, gaging of stream flow as well as furnishing plans for the dam and power house. The latter company was responsible for the supervision of the work and the general contracting, furnishing and executing the details plans. Mr. G. F. Harley was resident engineer for the J. G. White & Co. during the construction of the above plant and deserves the credit for the thorough attention and character of the entire work. The Lockwood, Greene & Co. mentioned above have been prominent engineers in Southern work for a number of years and have to their credit the engineering of the Saluda River hydro-electric development four miles from Greenville, S. C., which development on account of the favorable location, was recently purchased by the Southern Power Company and now furnishes power for the street car and lighting systems of Greenville and several mills in the territory. The above company made the preliminary survey and examination of the power sites for this plant and determined the general characteristics and costs of the development which is one designed to deliver over 2,000 H. P. during a dry season. The generators are three-phase, 60 cycle, 13,000 volts and consist of five units. The plant cost approximately $375,000 including the substation in Greenville, motors, transformers and pole lines to customers. A complete description of this plant appears in the March, 1911, issue of SOUTHERN ELECTRICIAN.

A further development engineered by this company, is the hydro-electric plant of the Yadkin Power Company which is described above. In this case the Lockwood-Greene & Co. acted as hydraulic engineers. Further than water power developments, this company has engineered and designed a number of cotton mills through their Southern office at Greenville, S. C., under the direction of District Manager R. E. Barnwell and District Engineer R. E. Thayer.

The development at Goat Rock, Columbus, Georgia, for the Columbus Power Co., is being engineered by the Stone & Webster Engineering Corporation of Boston. The design and installation of this plant is entirely in their charge under the immediate supervision, as resident engineer of Mr. G. F. Harley, who as we have mentioned above was resident engineer for the J. G. White & Co. during the construction of the Central Georgia Power Company development at Jackson, Ga., Mr. Harley after the completion of that plant resigned from the latter company to take up duties with the Stone & Webster Corporation and have charge of the development at Columbus. Mr. Harley is a Southerner by birth, being born at Sparta, Georgia, and one of the few engineers who claim this state as their birth place and been connected as constructing engineer on developments of the most recent type and large capacity. His early experience has been extensive throughout the West in reclamation service and his present work stands as an able monument to his ability in the line of work which he is now engineering.

Further than the engineering of the development of the Central Georgia Power Company, which we have mentioned, the J. G. White & Co., of New York has also designed and constructed the 32,000 H. P. plant on the Oconee River, near Cleveland, Tennessee, for the Eastern Tennessee Power Co., this development has been commented on under the heading of Southern developments.

Another engineering firm which deserves special credit for engineering work performed in the Piedmont section is the one headed by Mr. J. E. Sirrine, at Greenville, S. C. Mr. Sirrine has spent 22 years in engineering work

in the Piedmont section of the South and has passed through the various periods of its development. As a Southerner by birth, he has had the keenest interest in all developments in his charge and can point to work performed during the last ten years including over 100,000 horsepower of water power plants, and over 100 cotton mills. This latter type of plant is a specialty of his company and he has designed and built mills of a total capacity of nearly two million spindles.

Mr. J. E. Sirrine was born at Americus, Georgia, December 9th, 1872, receiving his education at the Furman University at Greenville. Immediately upon finishing school in June, 1890, he became associated with W. C. Whitner, now of Richmond, Va., in a survey of a proposed dummy line from Greenville to Paris Mountain. After this work was abandoned, he became associated with Guild & White of Chattanooga and remained with them until 1891. He then returned to Greenville and commenced again on a resurvey of the proposed dummy line to Paris Mountain, remaining on this work until the summer of 1891, when he connected with C. T. Basset, of Orange, N. J., on surveys for the construction of sewerage systems in Greenville, S. C., Orange, N. J., Summer, N. Y., and Meriden, Conn.

In 1892 he was engaged as assistant city engineer in Greenville, S. C., in charge of the construction of sewerage systems. After the completion of these systems and until April, 1895, he was engaged in land surveying and small engineering work under his own name. In April, 1895, he accepted the position as resident engineer on construction of a cotton mill for the Lockwood, Green & Co., of Boston, and remained with them until February, 1902. The last three years of his connection with the above company, he was in charge of their Southern development, having complete control of all the construction work in the South. In February, 1902, Mr. Sirrine started business as a mill architect practicing under his own name and is still engaged in that work. His article on Southern Water Power Development which appears in another section of this issue gives a good idea of the nature of engineering for which he stands.

One of the best examples of water power developments of the Sirrine organization is the plant of the Electric Manufacturing & Power Company at Gaston Shoals, on Broad river, near Gaffney, S. C. This plant has a new type of reinforced concrete forebay, which was used the first time in this plant and which was designed and patented by Mr. Sirrine. Its peculiar feature lies in the fact that all the reinforcement is subject to tensile strain only, and the weight of water in the forebay has been utilized to give stability to the power house wall. In this way the power house wall was reduced from the ordinary thickness of 24 feet down to 3½ feet. Along industrial lines the company is now building a seven-story factory building for the R. J. Reynolds Tobacco Company at Winston-Salem, N. C. Two years ago a steam power plant was put in for them; and for the first time in the United States this company is using exhaust steam to dry tobacco.

In mill design and construction the following are types: Woodside Cotton Mills, Greenville, S. C.; Republic Cotton Mills, Great Falls, S. C.; Dunean Mills, Greenville, S. C.; Dunson Mills, La Grange, Ga.; Calhoun Mills, Calhoun Falls, S. C., and Watts Mills, Laurens, S. C.

Southern Public Utility Corporations.

There seems to be a growing tendency in this country toward the centralization of the financing and engineering of public utility companies. At the present time there are a number of combined engineering, managing, and financing companies which have seen the possibilities and proceeded to purchase, finance, and reconstruct, gas, electric and street railway properties in cities of medium size. Among companies of this nature are the H. M. Byllesby & Co., of Chicago, The H. L. Doherty Company, of New York City, The Stone & Webster Engineering Corporation of Boston, Mass. and the American Cities Company of New Orleans, La., handling work of an extensive nature and rapidly building up large systems.

The H. M. Byllesby & Company belong to what might be called the new school of public utility management. That is, the type of management that recognizes the equity of the public in all corporations requiring public franchises to operate. This company started its work about ten years ago as an engineering organization specializing in public utilities, such as electric light and power stations, gas plants, street railways and water powers and in a very short time a large part of the firm's energy was exerted in the operation and management of public service

H. M. BYLLESBY, PRESIDENT OF H. M. BYLLESBY AND COMPANY.

companies. Through its general headquarters at Chicago, it maintains a staff of engineering and commercial experts of high calibre and thus supplies utility corporations under its management with a quality of supervision and management which properties individually could not possibly afford. At the present time a total of fifty electric central stations, twenty gas central stations, three street railways, six central district steam heating plants, two telephone systems, and four water works are operated and managed by this company. Of this number eleven

are in Southern territory, located as follows: Mobile, Ala.; Fort Smith, Ark.; Oklahoma City, Muskogee, Ennett, El Reno and Sapulpa in Oklahoma; Pulaski, Wytheville, and Marion in Virginia; Louisville, Kentucky.

At the head of this concern as president stands Mr. H. M. Byllesby, who is one of the pioneers in electrical business. He has been variously associated in the electrical field, principally with Mr. Edison in connection with New York plants and was vice-president and general manager of the Westinghouse Electric & Mfg. Co. for the first five years of its career. Mr. Byllesby has been continually connected with the development of electric light, street railways, electric water power developments, and gas companies, since his first employment with Mr. Edison. Associated with Mr. Byllesby is another high type of business man, Mr. A. S. Huey, who is vice-president and in charge of the department of operation and management, of the company. Among public utility operators Mr. Huey is known as the most progressive and liberal executive in the business. His view is that electric, gas and street railway companies must exert every energy toward ascertaining the demands of the public and meet these demands in a thoroughly satisfactory way. At the head of the engineering staff of the H. M. Byllesby & Co. is Mr. Otto E. Osthoff, vice-president and chief engineer. He has had charge of the designing and construction of many large waterpowers, electric and gas plants, during the past few years of his connection with the company and has made himself prominent as a specialist in this particular branch of engineering. While he is yet a young man, his grasp of the problems involved extends to the commercial phases and is by no means confined to technical requirements. The new engineering developments of the company stand as evidence of the nature of his engineering activities.

H. L. Doherty Company.

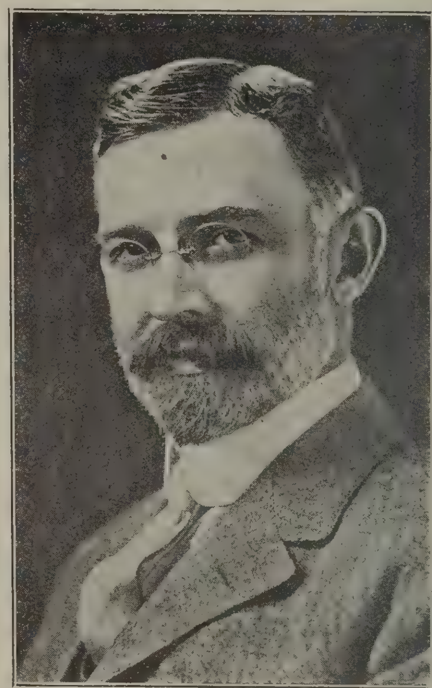
In the fall of 1910, a fifty million dollar corporation was organized known as the City Service Company, with Mr. H. L. Doherty, a leading and commanding figure in the commercial gas and electric field at its head. This concern controls the Denver Gas & Electric Co., of Denver, Colo., the Empire District and Electric Co., of Joplin, Mo., The Spokane Gas & Fuel Co., of Spokane, Wash., Montgomery Light and Water Co., Montgomery, Ala., the Meridian Light & Railway Co., of Meridian, Miss., The Hattiesburg Traction Co., of Hattiesburg, Miss., Knoxville Gas Co., Knoxville Tenn., Bristol Gas & Electric Co., Bristol, Tenn., and the Brush Electric Light & Power Co., of Galveston, Tex.as.

Mr. Doherty is also identified with the Doherty Operating Co., the Improved Equipment Company, the Combustion Utilities Company, the Trumbull Public Service Company, of Warren, Ohio, including the following companies other than those mentioned above in which he is the controlling factor. The Lincoln (Neb.) Gas & Electric Company. The Pueblo (Colorado) Gas & Fuel Company, The Lebanon (Pennsylvania) Gas & Fuel Co., The Massillon (Ohio) Gas & Electric Co., The Gas & Electric Securities Co., The Summit County (Ohio) Power Company, and the Urban Water Company of Brooklyn, N. Y.

The Doherty business getting methods are considered an example in the operating field and successful gas and electric corporation are following his methods. It is his rule to meet the public more than half way in all matters affecting the interest of both the corporations and the public and no complaint of the customer is too small to receive the attention of the managing company affected in any of his corporations. Mr. Doherty is a past-president of the National Electric Light Association and one of the earnest workers since its organization. The firm of H. L. Doherty Company began business in 1905 and has steadily advanced until it is one of the foremost in the gas and electric field.

Stone & Webster Management Association.

The Stone & Webster Management Association, acting as general manager for various public utility corporations, has been active in the South for a number of years. Its activities are also distributed well throughout the country, operating some 35 gas, electric and street railway properties. Of this number fourteen are located in the South as follows: The Columbus Railroad Co., Columbus, Ga.; The El Paso Electric Co., El Paso, Texas; Jacksonville Traction Co., Jacksonville, Fla.; Paducah Traction & Light Co., Paducah, Ky.; Savannah Electric Company, Savannah,



H. L. DOHERTY, PRESIDENT OF H. L. DOHERTY COMPANY.

Ga.; Dallas Corporation, Dallas, Texas; Northern Texas Electric Co., Fort Worth, Texas; Tampa Electric Co., Tampa, Fla.; The Pensacola Electric Co., Pensacola, Fla.; The Houston Electric Co., Houston, Texas; The Galveston Electric Co., Galveston, Texas; The Key West Power Co., Key West, Fla.; The Baton Rouge Electric Co., Baton Rouge, La.; The Galveston-Houston Electric Co., Houston, Texas.

American Cities Company.

During July, 1911, the American Cities Company was organized and constitutes one of the largest aggregations of public service corporations at present existing in the United States. The operations of the company include a number of the largest and most prosperous cities of the South, as follows: The New Orleans Railway & Light Co., the Birmingham Railway, Light & Power Co., the Memphis Street Railway Co., the Little Rock Railway & Electric Co., the Knoxville Railway & Light Co., and the Houston Lighting & Power Co. Through these organizations, the

company operates over 500 miles of street railways, controls the entire gas business of New Orleans, as well as the entire electric light and power business of the city, with the exception of a smaller electric company, a large part of the electric light, power and gas business of the city of Birmingham and the surrounding districts, the commercial electric light and power business in the city of Little Rock, Ark., the municipal and commercial electric light business in the city of Knoxville, Tenn., and the municipal and commercial electric lighting and power in the city of Houston, Tex. The president of the American Cities Company is Mr. G. H. Davis, of the firm of Ford, Bacon & Davis, of New York, who are the company's engineers.

Engineering Development in the Southwest.

Roosevelt Dam of the Salt River U. S. Reclamation Service in Arizona.

The Roosevelt Dam across the Salt River about 60 miles from Phoenix, Arizona, built by the U. S. Reclamation Service, is one of the large projects in the Southwest. The purpose of this dam is to irrigate about 250,000 acres of land in the vicinity of Phoenix, Ariz., and also to supply electric energy for various other purposes. Power generated at the site will be used partly for pumping water from wells in the Gila River Indian Reservation and in Salt River Valley south of Mesa, while the remainder will be sold for industrial purposes at Phoenix. Approximately 4,500 H. P. will be developed from a canal taking water at a diversion dam about 18 miles from the storage dam and about 5,000 H. P. from the Roosevelt Dam.

A 65 mile 40,000 volt transmission line will carry current from the station at Roosevelt to the Pacific Gas & Electric Company's plant at Phoenix. A branch 19 miles long is taken off at a switching station one and one-half miles northeast of Mesa and led to the pumping district south of Mesa and the Gila River Indian Reservation. The engineering work in connection with this development was carried out by the following: Mr. F. W. Newell, director, of the U. S. Reclamation Service, Arthur P. Davis, chief engineer, Louis C. Hill, supervising engineer for the Southwest, F. P. Teichman, designing engineer, and C. W. Smith, of the U. S. Reclamation Service, consulting engineer.

Development of Colorado River Power Co.

Another important hydro-electric development in the Southwest from an engineering and commercial standpoint, is the work nearly completed by the Colorado River Power Company at Marble Falls, and other points on the Colorado River. This development together with the plans and a description of the construction, was published in detail in the June, 1911, issue of SOUTHERN ELECTRICIAN. The dam is of the hollow concrete construction with the design of the power house section differing from that ordinarily adopted in this type of dam. The bulk head of the power house section is so designed that the machinery in the power house does not set directly below the bulk head, thus avoiding any possibilities of leakage and moisture affecting the apparatus. The ultimate capacity of the development will be about 12,000 H. P. The generators are 2,300 volt, three phase 60 cycle and the energy will be stepped up for long distance transmission to 66,000 volts. The engineering work in connection with the plans and the construction was in charge of the W. H. Zimmerman Co., of Chicago.

Activity at Fort Worth, Texas.

There has been considerable activity among electrical properties in the larger cities of Texas, among which is Fort Worth. The two lighting companies, the Fort Worth Light & Power Company, and the Citizens Company, were consolidated during the year into one company. The new corporation with Mr. J. R. Nutt, of Cleveland, Ohio, at its head, is incorporated for three and one-half million dollars. The properties have been improved and about one million and a half dollars spent in developing the system so as to handle the demand. The company will be able to furnish power to manufacturers at four cents per kilowat hour downward, depending on the factory load. This makes electric power a formidable competitor with natural gas and crude oil, obtained from the refineries in this district. An ornamental system of lighting has been installed and turned over to the city free of charge. Another advancement installed in connection with the operation of this system is the systematization of meter readings, reducing the cost of electric lighting in private homes it is said fully 25 per cent.

Developments in Oklahoma City.

The remarkable growth of Oklahoma City, with six times the population it had ten years ago and twice what it had four years ago, has made it necessary that electrical development keep up with such rapid progress. Six years ago the Oklahoma Gas & Electric Company was taken over by the H. M. Byllesby & Co., of Chicago, and at that time the Company had in service one meter to every 30 in population. Now there is one meter to every eight people. At that time the elctric plant had a capacity of 850 K. W. including the generating capacity for the street car service. At the present time the light and power company has a capacity of 5,500 K. W. and the railway company has a capacity of 5,000 K. W. making a total of 10,500 as against 850 six years ago.

The Oklahoma Gas & Electric Company is now maintaining over 9,000 electric meters, has 800 miles of wire in service and supplies current for 150,000 fifty watt equivalent lamps for interior lighting, 500 city arcs and about 6,500 H. P. in motors. It is also noteworthy in connection with the operation of this central station that while there is an abundance of natural gas and coal and both sell at a moderate price, there are very few steam power plants in the city and only where steam is essential to other parts of the business. It is stated that every office building in the city is equipped with electric service taken from the central station and all the most desirable and recently built, are equipped with vacuum cleaners, air compressors, house pumps, and cold water systems, all electrically driven. The above progress places Oklahoma City among the most progressive and up-to-date of any electrical center in the South.

Libraries should have the outlets so disposed as to give an even distribution of light over their entire working area. Generally this light should be either reflected or diffused. Direct, unshielded light, with brilliant shades, is unfitted for use in libraries. The same is true of art galleries, which particularly require a diffused light.

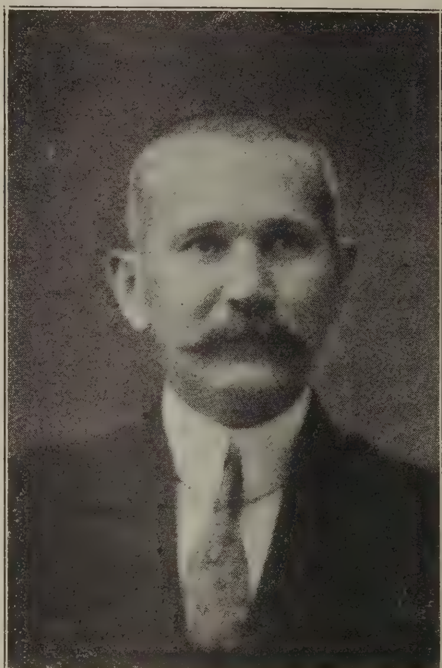
Electrical Sign Development Throughout the South.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY J. E. TUCKER.

WHEN considering the various features of electrical progress throughout the South during the past few years, there is one which has appealed to the masses and with which every citizen is familiar and in sympathy. The writer refers to the illuminated sign and the "Great White Way." Along both these directions, the South as a whole has made such rapid strides that it is ahead of any other section, excepting perhaps those sections including the larger Northern cities and a few Western cities. There are few Southern cities or towns with a population of ten thousand and upward that cannot boast of having a "Great White Way." And where this form of advertising has made rapid progress few high class businesses are without the electric sign.

The credit for this development in the South is largely due to the central stations. Their New Business departments are composed of not only salesmen, but advertising men that are able to show their prospective customer the advantage of this most modern method of publicity. They call on the sign manufacturer for attractive designs and lay before the customer an individual sketch, explaining the advantage of each advertiser having something different from the other, which usually clinches the sale. Further the majority of signs are sold to, or by the central station. Through the purchase of a number of signs, they get them at a less cost than the individual, and it is a custom with the central station to permit the customer to pay for signs in small payments, thereby placing this form of advertising practically on the same basis with the newspaper and other mediums. The central station also takes the responsibility of erecting the signs, looking after the upkeep and turning on and off.



J. E. TUCKER, VICE-PRESIDENT AND GENERAL MANAGER OF GREENWOOD ADVERTISING COMPANY. A PIONEER IN ELECTRICAL ADVERTISING IN THE SOUTH.

The cheerfully illuminated thoroughfare by means of signs and display lighting has appealed to civic pride. There is hardly a city in the South that has not made an ordinance in favor of signs, permitting them to extend to the curb line, and requiring that they be illuminated up to a given hour each night. In visiting a city where this development has taken place and looking down the main streets at night attention is called to the number of people that are on the streets as compared with the olden days, before this method of illumination put in its appearance. While it is true that other methods of street lighting have been adopted in recent years, which have done much to beautify the main streets, the electric sign is adding a distinct feature. A large number of colored and movable signs is now the true indication of a wide awake city. Their mission is performed silently and in doing it, furnish entertainment. While the advertiser is paying for the signs and this entertainment the prospective buyer is unconsciously being directed to his place of business and developing into a profitable customer.

Not only the merchant and manufacturer have taken advantage of electrical advertising but the daily press as well throughout the South. Among the leading dailies using this form of publicity is the *Mobile Register, Atlanta Journal, Memphis Commercial Appeal, News-Scimiter, Nashville Tenneeseean American, Nashville Democrat, Tampa Tribune, Augusta Chronicle, Chattanooga News, Knoxville Sentinel, Montgomery Advertiser.* A number of these papers are displaying large spectacular signs, which they recognize as a desirable medium for publicity. Banks have also been active along this line. There is hardly a city where there is not one or more banks displaying signs.

An interesting point in regard to sign development is the fact that the merchant or manufacturer who puts up an electric sign never takes it down except to make room for a larger one. It is also true that new buildings are being erected with preparations made for electric signs in the plans, very often the sign being installed before the place is open to the public.

One of the factors giving the electric sign its impetus in the South is its use by a number of large manufacturers and national advertisers in the large cities. There is a large sign erected in Atlanta, Ga., and shown herewith, advertising Red Cross Mattress and Blue Ribbon Bed Springs. After this sign had been up for a period of four or five months, the president of the company operating the sign said that his business had increased at least fifty per cent locally, and that they had felt the weight of the advertising throughout their territory. Another manufacturer of table syrup, the Alabama Georgia Syrup Co., installed a sign at Montgomery, Ala., about two years ago, and have recently made a larger installation at Birmingham. Mr. L. B. Whitfield, president of the company, has said that he is thoroughly

FIG 1. BRISTOL'S CIVIC SIGN ERECTED BY THE BRISTOL GAS AND ELECTRIC COMPANY.

convinced of the field for and the merits of the electric sign through his experience. Further as an indication of the extension in use for general advertising, the American Bakers Candy Co. of Birmingham have erected three signs in the past eighteen months. The most recent sign is placed on a roof, plainly visible from both the railroads and sidewalks, and is a forceful one advertising Merita Chocolates and Biscuit.

The advertising of a municipality through an electric

FIG. 2. CENTRAL STATION SIGN AT OKLAHOMA CITY.

FIG. 3. CIVIC SIGN AT SAPULPA, OKLA., ERECTED BY THE SAPULPA ELECTRIC COMPANY.

sign is a recent development and one which attaches to the scheme where employed a suggestion of general progressiveness and commercial aggressiveness. Good illustrations of this type of sign are shown from Montgomery, Ala., Sapulpa, Okla., and Bristol, Tenn. The sign installed at Montgomery was the first of its kind to bear the name of a Southern city. It is located at a commanding view, and due to the flashing effects of the wording, combined with the rocket effect, the result is decidedly spectacular.

The Saapulpa sign was installed in June, 1911. The sign proper is 20 by 32 feet, the distance between poles being 45 feet. It contains about 1,000 five-watt Mazda lamps and is burned from dusk until twelve o'clock and from four o'clock in the morning until daylight, these hours covering the arrival and departure of trains from which it is visible. The operation of the sign is as follows. The border burns continuously, "Sapulpa" appears first, "The Oil City" second, "Of the Southwest" third, and the burning oil effect about the "Oil" laast. Then all becomes dark and repeats.

The Bristol sign was placed in operation July 4, 1911.

FIG. 4. MONTGOMERY'S CIVIC SIGN ERECTED BY THE MONTGOMERY LIGHT AND WATER COMPANY.

FIG. 5. A SKY SIGN AT MOBILE ALA., ERECTED BY MOBILE ELECTRIC COMPANY.

This sign is 30 feet high by 60 feet long, contains 700 white lamps, 100 red and 100 green, a total of 900 lamps. The word "Bristol" remains stationary, the "Star" scintilates, the "Arrows" flash followed by the words "Va-Tenn," and the word "Push" spells itself followed by "That's Bristol," making a beautiful effect. This sign was erectetd at a cost of $1,200, and was designed by Mr. George Williams, of Henry L. Doherty & Company, New York. It is maintained in the matter of lamp renewals and current by the Bristol Gas & Electric Company. The sign is most advantageously located, facing the railroad, and can be seen by everyone passing through Bristol and for miles around the surrounding country.

The illustrations shown herewith representing sign activity in Meridian, Miss., bring out a feature of electric sign advertising which makes it forceful, attractive and lasting, namely, individuality. The signs shown are only a few of the ones installed during the past 18 months. While the Meridian Light and Railway Company does not claim particular progress in numbers of signs installed, it has every reason to be proud of those now operating due to quality

FIG. 7. SIGN AT MOBILE, ERECTED BY MOBILE ELECTRIC COMPANY.

and style and from the fact that all classes of business are represented. By installing a large roof sign for the leading newspaper, one for the leading bank, another for the largest jewelry house at the outset, such impressioins were formed that other classes of business immediately fell in line. Today thirty-two different classes of business are represented by electric signs, including one on a church.

The outline lighting illustrations show lighting effects during the October Mississippi-Alabama Fair. The idea was conceived that a splendid opportunity was present of impressing on the local as well as the visiting public what electrical advertising will do for a city. Fifteen thousand

FIG. 6. DECORATIONS DURING MISSISSIPPI-ALABAMA FAIR BY CITY AND MERIDIAN LIGHT AND RAILWAY COMPANY.

Fig. 8. Broughton Street, Savannah, Showing Large Number of Signs.

Fig. 10. Sign at Augusta Erected by Augusta-Aiken Railway and Electric Corporation.

feet of festoon outlining was secured and the downtown district decorated. Also through the Board of Trade, a large welcome sign, with a large waving American flag immediately beneath it, was erected over the thoroughfare going to Fair Grounds. This illumination made a most favorable impression on every one visiting Meridian.

One of the most interesting electric sign developments in a Southern City has taken place in Savannah, Ga., during the past four years. The electric sign campaign had its inception with the coming of the Savannah Lighting Company, before this time the business streets were poorly lighted and few people on them after nine o'clock. At first the campaign progressed slowly, for the merchants could not see the necessity or advantage of spending money for an electric sign when there would be no one on the streets to see them. After the great white way was installed, however, and two or three signs in operation, more people used the business streets for promenading and the merchants gradually came to a realization that the opportunity was present to introduce the passers-by to their stores and convert them into customers. Following the introduction of the electric sign and white way in Savannah came the frequent changing and dressing of show windows, which helped to attract the attention of the passer-by and supplement the work of the sign.

The conception of the electric sign business in Savannah and much of the credit for the installation of the first

Fig. 9. Signs Erected at Meridian Miss., by Meridian Light and Railway Company.

ornamental curb post lighting system in the South is due Mr. Sam H. Brown, formerly of the organization of the Savannah Lighting Company, now with the Georgia Power Company at Gainesville, Ga. His success in Savannah may be attributed to his earnest and firm faith in electrical advertising and to the liberal policies of the company he represented. All signs were purchased for the customer, erected and maintained allowing the customer 36 months to pay for them and operated at a flat rate depending upon the number of lamps used. The co-operation of city council was secured, the street committees, and director of public works in arranging satisfactory ordinances and installing the signs so as to beautify rather than detract. The white way including the signs of Savannah has not only created favorable public sentiment in the city but has influenced to a marked degree the activity of other cities along the same lines.

Some of the Savannah signs are shown in the illustration presented here. One of the first Savannah signs, however, was the one on the First Presbyterian Church, made up with perforated letters. It created considerable favorable comment and admiration.

At Shreveport, Louisiana, a white way has been installed and at the present time the Shreveport Gas, Electric Light and Power Company has over 100 signs in operation. These signs are installed on from three to five-year contracts with rates varying on size of sign and length of time burned. The average rate is about four and one-half cents per kilowatt hour. The company has installed a lighting system of 14 lights per block without charge to merchants, further than nine cents per lineal foot of store front for operation, making an average charge of about 4.5 cents per kilowatt hour.

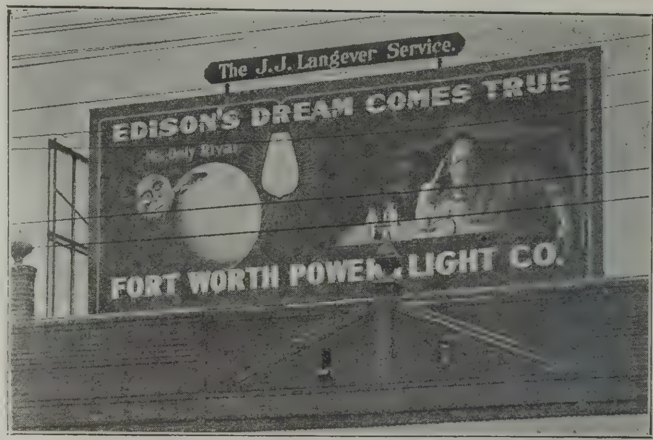


Fig. 12. A Prominent Sign at Fort Worth, Texas.

In Memphis, Tenn., three years ago only five electric signs were installed. At the present time over 300 are in operation which together with the special window display represents a load of 525 Kilowatts. The central station sells the signs erected and charges for operation on a flat rate contract computed on $125 per K. W. year, when lights are used from dusk to midnight.

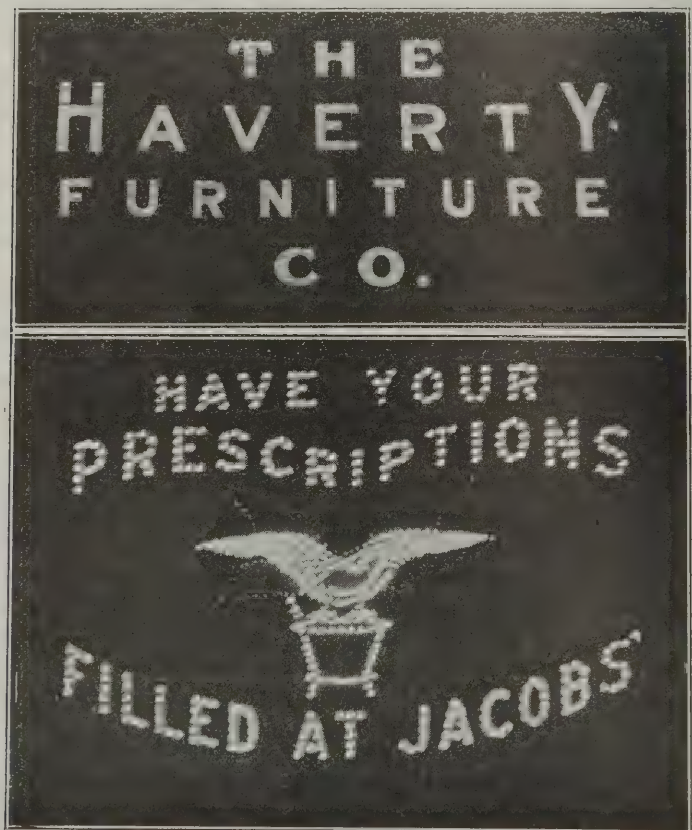


Fig. 11. Atlanta Signs Erected by Georgia Railway Electric Company.

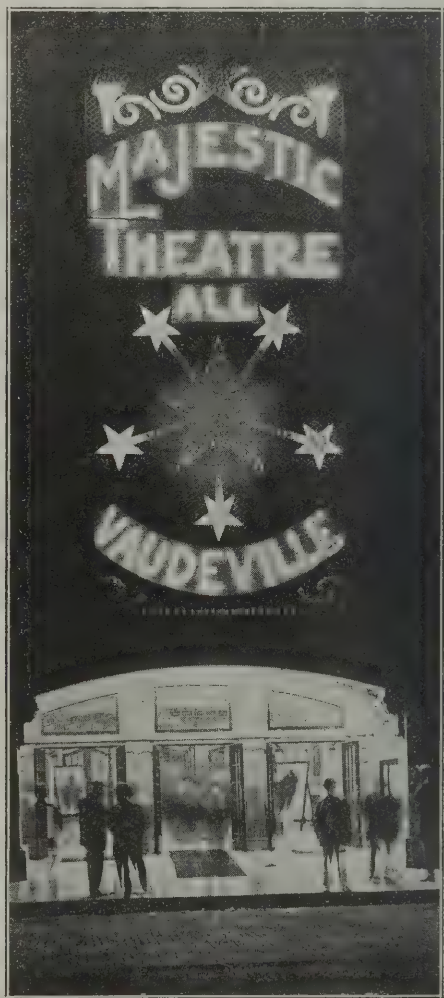


Fig. 13. A Striking Theater Sign Erected by Fort Worth Power and Light Company, Using 5 Watt Mazda Lamps.

FIG. 14. SPECTACULAR SKY SIGN AT ATLANTA, GA.

One of the largest electrical signs now in operation in the Southern States, has recently been erected by the Southern Spring Bed Company at Atlanta, Ga., on the corner of Peachtree Street and Auburn Avenue, commanding a prominent position from the most congested part of the city. On account of its height and spectacular nature, it is noticeable and distinct also from many of the buildings surrounding it.

The structure is erected on the roof of the buildings as shown in the accompanying illustration. There are two complete signs differing entirely in their general contour and reading matter, yet so arranged with flush face and groove letters as to prevent the slightest appearance of the structure of one sign, while the other is being operated. The main structure is 59 feet high above the roof, and 110 feet above the street. It is 42 feet wide from tip to tip, being constructed with steel, the weight of which is about 15,000 pounds. The lamps illuminating the sign are white, red, green and amber, requiring 1346 two candle power lamps to present the display. The lamps are controlled by

FIG. 15. SIGN AT AUGUSTA, GA., ERECTED BY AUGUSTA-AIKEN RAILWAY AND ELECTRIC CORPORATION.

FIG. 16. SIGN AT ATLANTA ERECTED BY GEORGIA RAILWAY AND ELECTRIC COMPANY.

a combination fourteen double pole carbon knife switch and ten point high speed flasher. A wonderful effect is obtained through torches which flame forth from their towering position high above all the surrounding buildings. It is the torch feature of the sign which appears first, then "Red Cross" in red lamps, then "Sanitary Mattress," then the figure in the bed and "Southern Spring Bed Company" in vari-colored lamps. The complete display then disappears, allowing time and space for the second sign, which reads "Blue Ribbon Spring Twenty Year Guarantee" with the figure in the bed and "Southern Spring Company" reappearing, making a pleasing contrast to the previous sign.

This sign installed complete, cost approximately $2,200 and operates on a flat rate basis of $133 per month. When all the lamps in the sign are in operation the maximum current demand is about 78 amperes. The sign was designed by the Georgia Railway & Electric Company, of Atlanta, and installed by them.

It may be advisable at this point to say something about the character of a sign that is in demand and point out the mechanical and artistic features. The writer is of the opinion that the sign manufacturer should secure the approval of the National Board of Fire Underwriters on his product, since all material used in the construction of signs is specified by them. This is certainly a safeguard for the Central Station and user as well. It requires considerable experience to manufacture signs to produce good results, as many central stations have learned through a trial of the work turned out by the tinsmith or the sign painter. He is neither experienced or well equipped to do this kind of work, and spectacular features are entirely foreign to him. Signs should be equipped with the best type of flasher, as a poor type of flasher is constantly giving trouble.

When looking down the main streets of the more progressive Southern cities the average person wonders if there is any more room for signs. The sign manufacturer will state on this point that the opportunities are greater for larger and better business where this is in evidence. So there will be signs, and more signs, and the world will be brighter and better for it.

Electrical Progress and Developments During 1911.

(*Written Exclusively for* SOUTHERN ELECTRICIAN.)

THE year 1911, like its immediate predecessors, does not record any remarkable inventions or startling improvements in the electrical field. There has, on the other hand, been a general tendency to standardize developments already made and further perfect existing models. The activity among the various manufacturers in practically every case bears out this statement. The following information is arranged to show up the particular lines of progress and development.

Considering the progress in generating equipment the past year has developed no radical changes in the standard lines of this equipment and little development has taken place aside from the water wheel driven A. C. generators, and 60-cycle, 2 and 3-phase belted A. C. and engine driven D. C. machines. Unlike generators driven by other prime movers, those connected to water wheels for any given Kva capacity may be called upon to operate at speeds which are extreme in both directions. For instance a 300 Kva. generator may be built to run at 72 r. p. m. and also at 720 r. p. m. or even higher speed. Further developments along this line have made possible the operating of four thousand Kva. generator at a speed as low as one hundred r. p. m. and as high as 514 r. p. m. In regard to capacity, the equipment for the Canadian Niagara Company at Niagara Falls, including a 10,400 Kva Westinghouse generator and the generators for the Rio de Janeiro Tramway Light & Power Co. at Brazil of 12,500 Kva capacity are typical examples of water wheel generators of large size.

The installations of water wheel driven generators during the past year have included both the horizontal and vertical types. Of the vertical type, General Electric design, 3,000 K. W., 25 cycle machines, running at speeds of 300 and 250 have been designed and installed. These are similar in general appearance and design to 300 r. p. m. 40-cycle vertical shaft generators built by the same company for installation in the plant of the Schenectady Power Co. at Schaghticoke, N. Y. The design of vertical machine of special interest, is that to be installed at Tallulah Falls, Ga., in the plant of the newly organized Georgia Railway and Power Co. This machine has a normal rating of 10,000 K. W. at a speed of 514 r. p. m., three of this design being installed in the plant above mentioned. These generators are interesting in that they probably have the highest peripheral speed of any definite poled generators yet built, in connection with which there is an overspeed requirement equal to that of the runaway speed of the water wheels. In the plant of the Appalachian Power Co. of Virginia, generators of 4,000 K. W., operating at 116 r. p. m. and 2,300 K. W. generators operating at 97 r. p. m. for 60 cycles, 13,200 volt service have been designed and are under construction.

The lowest speed generator of either horizontal or vertical type yet built of General Electric design is a 9,000 K. W., 3-phase, 25-cycle, 11,000 volt type to be installed in the plant of the Mississippi Power Co. at Keokuk, Ia. This machine weighs complete 600,000 pounds and operates at a speed of 57.7 r. p. m. Horizontal shaft generators of ordinary capacity and speed of General Electric design developed during the past year have nearly all been for 60-cycle service. The highest speed machine of this type is a 50-cycle generator rated at 7,000 K. W. operating at 500 r. p. m. There is under construction a 60-cycle, 13,900 Kva 4,000 volt generator operating at 200 r. p. m. for the Washington Water Power Company at Spokane, Wash.

In the design and construction of the standard line of Parsons reaction turbine with accompanying generators of the Allis-Chalmers design, the tendency has been toward higher speeds for alternating current units. There is also being developed a line of turbines of the same type to drive through reduction gearing, direct current generators in the larger sizes. A feature of the latter is the fact that they are standard machines of the same design as those forming the direct current ends of the company's motor generator sets. In the construction of hydraulic turbines of Allis-Chalmers design, the demand requires designs for high heads in large high speed reaction wheels with generators to correspond.

The activity in the field of alternating current turbo-generator design has been typical of the demands and requirements from this field of operation. While no machine as large as the 20,000 K. W. New York Edison generator has been installed during the past year, there is a tendency toward increasing the capacity of such equipment. There is nothing impossible or impractical in connection with much larger machines of this type than has ever been built and it is expected that progress will be made along slight improvements in the designs of standard machines. The developments in horizontal shaft turbo-generators of the General Electric design have been for the most part in operating at higher speeds than with the vertical shaft type of the same capacities that have been built hertofore. Sixty-cycle horizontal shaft generators at speeds of 360 r. p. m. have been developed in 300, 1,000 1,500 and 2,000 K. W. These supplement the previous list which included 100, 500 and 750 K. W. machines. The features of interest of the new machines in sizes of 1,500 and 2,000 K. W. are the higher peripheral speed and consequently a mechanical construction which takes care of greater centrifugal stresses than heretofore handled. There has been developed further than this line, a design of 60-cycle, 750 K. W. 1,800 r. p. m.; a 25-cycle, 750 K. W. 1,500 r. p. m. and a 30-cycle, 750 K. W. 1,800 r. p. m.

In the vertical type generators of General Electric design, 20,000 K. W. machines have been built during the past year, wound for 6,600 volts. One of this type is now in operation at the Waterside No. 1 plant of the New York Edison Co. at New York. The design of this equipment is intetnded to replace reciprocating engine units of 3,500 K. W. capacity. In the field of small turbo-units, a line of impulse turbines direct coupled to alternating current generators in sizes of 100 to 200 K. W. and to direct current

generators from 25 to 200 K. W. have been developed according to Allis-Chalmers design.

During the past year a new type of Westinghouse direct current engine driven generator has been built. These machines are of the commutating construction and range in size from 25 K. W. to 1,000 K. W. The frames of this machine are of cast steel and the ventilation has been carefully worked out with promising results. Very good commutation is secured through the interpole design which is used, and makes up the first complete design of interpole engine type generators of all voltages which have been available heretofore. Generators to be driven by gas engines have been developed for both 25 and 60-cycle service, most of these being of small capacity from 100 to 500 K. W. and speeds from 100 to 250 r. p. m. However, somewhat larger sizes, in 1,500 to 2,000 K. W. at speeds of 75 to 107 and frequencies of 25 to 60 cycles have been developed.

In belt driven A. C. generators, a new line of General Electric 60-cycle, 2 and 3-phase generators have been constructed which are equipped with or without direct connected exciters. The desirable features of this design are that standard machines are readily available for adoption to either synchronous motors with good starting torque or for exclusive use as synchronous condensers.

The synchronous condenser has become generally recognized and the requirements in the operating field have demanded a development of sizes for operation on systems of from 25 to 50 cycles. A 50-cycle, 2,000 Kva 10,000 volt synchronous condenser has recently been constructed for the Southern California Edison Co. Further in this regard it is becoming more usual to require condenser effect is synchronous motors of motor generating sets and this has necessitated the redesign of many of the motors in standard sets, resulting in there now being available either a motor for supplying energy alone, or one for both energy and magnetizing current to assist in controlling power and voltage.

Rotary Converters and Motor Generator Sets.

Rotary converters and motor generator sets have now found their way to an extensive field of application in connection with industrial operation. The development in this line of apparatus has been mainly in the design for high voltage service. While very few single rotary converters for 1,200 or 1,500 volts have been placed in operation by any manufacturer, there is every reason to believe that the ensuing year will see a number of properties where individual 25-cycle rotary converters of 1,200 and 1,500 volts direct current will be used for transforming alternating to direct current. It is expected that Westinghouse rotaries will be of the interpole design on account of the progress which has been made along this line. A considerable demand has manifested itself during the past year for large rotary converters. Several Westinghouse 3,000 K. W., 25-cycle rotaries have been manufactured and a rotary of 3,000 K. W. equipped with interpoles and especially designed to meet heavy swings resulting from the excessive acceleration requirements of subway ten-car express trains, constructed for the Interboro Rapid Transit Co. of New York City.

The general progress in 60-cycle rotary converter design during the past two years, has been in higher speed, permitting much better electrical design and insuring reliable and continuous operation. Difficulties of bucking and flashing over and a sensitiveness to brush position in the older designs of 60-cycle rotary converters, are now problems which are practically overcome in the designs of the newer types.

The maximum size of alternating to direct current, motor generating sets has not increased during the year, but sets of approximately 1,000 K. W. capacity are being more frequently used. During the last year there has been installed in the plant of the Rio de Janeiro Tramway Light & Power Co. a third 2,000 K. W. synchronous motor generator set. On account of the conservative rating of this machine which normally would be rated at 2,700 K. W., it is probable that it is the largest A. C. to D. C. motor generator set that has been yet installed. The direct current generators of all Westinghouse standard motor generator sets are of the interpole design.

The gasoline electric generating set has been practically developed and has been installed for isolated plant service giving very satisfactory results, especially when installed on the farm, in the hotel, and other places where central station service is not available.

High Tension Transmission.

The subject of high tension transmission has recently received considerable discussion based on practical experience at recent meetings of the American Institute of Electrical Engineers and the general trend has been altogether favorable to this method of delivering power over long distances. The centralization of power generating facilities is a feature of recent electrical development and introduces new problems of transmission and distribution. Energy in larger quantities must be delivered over longer distances and over wider areas, resulting in conditions which necessitate plant consolidation and the substitution of large and more economical equipment instead of small and inefficient stations. The design of high tension systems are, therefore, fast becoming standardized. When the amount of power transmitted is considerable it is now considered more economical to install steel tower construction with wide spacing and the suspension insulator which has proved of considerable value through its flexibility of attachment. Advantages are at the present time obviously those permitting the use of almost any voltage which the transforming, switching and line equipment will stand without insulation puncture at the ends or at tapping point, or with excessive loss of energy by electrostatic dissipation at extra high potentials on long lines. The cost of the pin type insulator increases nearly as the cube of the voltage above 60,000. There is still considerable room for improvement in the minor fittings used in connection with suspension insulators and in methods of installing line wires where this type is employed.

The use of 110,000 volts for transmission purposes is now well established, and designs are under way for 140,000 volt apparatus which seems to be the next advance. The test on the lines of the hydro-electric power commission of Ontario, at 165,000 volts indicates to the designing engineer that this is undoubtedly the second step in advance above the 110,000 volt system. The day has now arrived when there are no engineering difficulties to prevent the building of transmission lines of high voltage and great lengths except financial consideration, the limit placed by such being about 400 miles.

In the development of the higher transmission voltages,

transformer designers have the least to fear since cases of transformer breakdown are exceedingly rare in modern designs. Transformers for a 150,000 volt transmission line are even now under construction by the Allis-Chalmers Co. for service on the Pacific Coast on the lines of the Nevada California Power Co. These transformers will be 4,000 Kva single phase, 60-cycle, oil filled and water cooled. They are designed for 36,000 and 6,600 volts on the low tension side, and 87,000 volts on the high tension side. Three transformers form a group which will be connected in delta on the low voltage side, the high tension side being connected in Y giving the 150,000 line voltage.

The substation in connection with any high tension alternating current distribution system is a factor which needs careful consideration and in which there is at the present time little standardization in design. The type of line anchorage and entrances are subjects of importance and affect in a general way, the design of building and its location. There is much discussion in regard to the use of roof and wall entrances for lines. This is a considerable problem and must be determined as the line entrance affects the planning and arrangement of the inside of a station. At the present time, however, line entrances for high voltages are largely in an experimental stage, and there are about as many methods for bringing lines into the station as there are high voltage developments supplying power. Roof entrances for a line seems to be the simplest to install and in most cases causes the least modification in the structure to accommodate them, and generally make it possible to bring the lines in at a point which give maximum saving in space and direct wiring. The protected entrance seems to be one most generally used, usually made at the side sheltered by a protection of the roof if horizontal or set at an angle or mounted in a hood if vertical.

Improvements on transformers recently have been in improving materials and better mechanical designs. The subject of insulation has been given special attention, as upon this the life of the transformer largely depends. The insulating materials now used are of better quality both mechanically and electrically with the result that a further increase in efficiency and reduction of exciting current has been obtained. In connection with the insulation the high tension coils have been further subdivided to reduce the voltage between the layers of the winding as well as between coils and thus relieve the strain on the insulation. Slight changes have also been made in the terminal bushings to further prevent possibility of grounding to case due to the collection of dust between the bushing and the case, and still further make the syphoning of oil from the case impossible.

Electric Power Utilization.

With the general broadening of electrical application, comes increasing evidence during the past year of the reliability, efficiency, economy and satisfaction of the electric drive. Motors, both alternating current and direct current, are being standardized for the various classes of work, which they are required to perform, the alternating current motor, now being the important factor in the industrial field. A reversing type polyphase motor of General Electric design has recently been developed and this motor will find a wide field among those applications where the frequent reversal is required. Further, the past year has marked a greater tendency to use the collector ring, form wound motor, for varying speed service as well as the multi-speed unit having stators wound for different polar groupings, thus allowing electrically, severally fixed speeds independent of a load within a given rating. The commutating pole motor has met with gratifying success and the use of the commutating poles for direct current motors may now be considered the standard practice in sizes approximating 2 H. P. and above. This design assures superior commutation, with a fixed brush adjustment, and gives better overload capacity, a flatter speed curve, and finally the design permits better all day efficiency than motors without commutating poles.

Developments in Electric Heating Apparatus.

The principal commercial applications that have shown the largest advance during the past months are commercial cooking made possible by the improved designs of the larger pieces of apparatus for the hotel and residence kitchens, namely, the range broiler, and large toaster, and other similar utensils. Commercial baking is being encouraged by central stations, giving special rates to large bakers. In anticipation of the tendency toward a general use of the smaller heating and cooking devices in the home, nearly all manufacturers have enlarged their lines in this direction and include nearly every utensil used to any extent for heating or cooking in the home.

The increasing use of electric heating in industrial lines has made necessary new applications and improvements on old applications of heating, especially in those devices used for industrial purposes, and in publication work. Large melting pots, liquid heaters and crematories are now in operation.

The so called fireless cooker idea is being worked out in both small sizes and in range sizes in which a small amount of current will be used continuously every hour, the heat generated thereby being stored up in well insulated compartments, and ready for use as required by the oven the broiler or disk stove.

Progress in Electric Lighting.

Considerable progress has been made during the past year in the industrial and street lighting fields. Up until very recently factory lighting has been either a matter of ordinary incandescent lamps or of ordinary arcs, the former being used where individual lights over machine were desired, the latter where a general lighting scheme was tried. A building for industrial purposes is primarily intended for use by day and the fact that it must now and then be lighting in the late afternoon or evening, commonly drops out of sight in the design ,although for economic reasons, it is necessary. The fault with the former plan of illumination in industrial plants has usually been that the working space as a whole has been left in darkness and the light sometimes too little and sometimes too much has been focused directly on the work. From the standpoint of actual foot candles delivered, the result has been striking. From the standpoint of seeing it has often been extremely bad. The direction toward which illuminating engineers are working in this field is toward lessening the amount of localized light and using the energy thus saved to provide a moderate degree of general lighting, improving the seeing conditions very much.

The illuminants which are now playing an imporant part in industrial work are the flame and luminous arcs mercury arcs, and to considerable extent the large sizes of tungsten units in 250 to 500 watt sizes. The tungsten or so called Mazda cluster, comprising a group of tungsten

filament lamps beneath one large metal reflector has received very favorable recognition in industrial lighting. Where large units from 1,000 to 2,500 candle power are required, it is necessary to fall back upon the arc and the so-called intensified carbon arcs worked at a very high current density prove useful. These are approximately of the same efficiency of the tungsten lamp and present the advantage of giving a light that is both steady and singularly close to white.

In the street lighting field the large number of extensive ornamental street lighting systems installed makes this the important development. During the last two years about one third of the cities of the country with a population greater than 50,000 have installed or have decided to install systems of ornamental lighting. The tendency in this class of lighting at present is to use standards, employing both the upright and pendant balls. In some places, five 100-watt lamps are installed and others a 100-watt lamp upright and four 60-watt lamps in pendant balls. It is the general rule that in case of two sizes of lamps, the pendant lamps are always the smaller. The spacing distances range from 50 to 75 feet with a general average of about 65 feet. The height of posts is usually twelve feet to center of pendant balls. The engineering department of the National Electric Lamp Association has given considerable attention to ornamental lighting and have determined upon the use of pendant and upright balls for each post as the better system, because of the fact that better illumination is secured. The reasons usually given are because there is no tendency toward shadow cast by cross arms and also because the lamps are nearer the plane of illumination.

Developments in Water Power Systems.

The larger recent water power developments are of special interest as they demonstrate the feasibility of successfully and efficiently supplying currents for all kinds of work over hundreds of square miles of territory. Power is being furnished from any number of water wheels and steam turbine units located at widely different points. As a rule the endeavors in connection with water powers feeding over long high tension distribution lines is to operate under nearly constant load thereby obtaining the maximum efficiency of the water wheels and transmission, while the turbine stations generally located near the center of distribution systems take the load fluxuations and control the frequency. The important advances made in hydro-electric installations have on account of the experience accumulated from various stations installed, included nearly every department of the work. The design, size and construction of water wheels, both of reaction and impulse types have been improved for the better and the development of high tension electrical apparatus including transformers, line insulators, steel towers, etc., have made transmission both practical and free from the earlier faults. Today power is being handled at 100,000 volts over 150 miles of line as successfully and as efficiently as ten years ago it was handling at 50,000 over half of this distance. At the present time at least five heavy power transmission systems are successfully and economically delivering current from 50 to 150 miles at from 100,000 to 110,00 volts. Above 110,000 volts air begins to lose its perfect insulation qualities and a slight leakage or discharge from the conductors takes place known as the corona effect. It cannot exactly be said at the present time to what extent potentials higher than 110,000 volts can be efficiently used, yet it is known that transformers, oil switches, and line installators can all be built for much higher voltages than are used at the present time. The insulation of the air alone therefore limits the line potential. The subject of corona has had frequent discussion and especially interesting material has been presented before the engineering societies during the past year.

Electric Traction Development.

The past year has witnessed much activity in the increase of equipment by electric railways in all sections of the country, the electrification of steam lines and the development of electric railway apparatus. A number of steam railroad companies have either commenced operation of electric lines or have placed orders for additional electrical equipment. The New York Central and Hudson River Railroad is actively at work extending its terminal electrification at New York City to Croton, a distance of about 40 miles from the Grand Central Terminal. During last June the Southern Pacific commenced the operation of electrified suburban lines in the vicinity of Oakland, California. These lines are operated on the 1,200 volts direct current railway system, the initial installation including 65 motor cars, employing the overhead trolley system and receiving current from twenty, 750 K. W. General Electric rotary converters connected two in series. The Baltimore and Ohio Railroad was the first steam railroad in this country to adopt electric operation and is adding to its large equipment of electric locomotives, two of the same types as installed two years ago. The Pennsylvania Railroad in conjunction with the Hudson and Manhattan Railroad will shortly commence electrical operation between New York City and Newark, N. J.

A number of interurban railway companies have during the past year installed 1,200 volts direct current railway apparatus. Of these, the Fort Dodd, Des Moines and Southern Railroad, has been operating for a number of years with 600 volt trolley systems and on account of a large amount of freight business handled the operation of larger train units was desirable and the 600-volt system replaced by a 1,200 volt system over the entire electrical division. This road has about 140 miles of track. The Oregon Electric Railway of Portland, Oregon, is now operating over 70 miles of road, and has recently placed orders for the necessary equipment to change to the 1,200 volt D. C. system. Some 70 miles of additional road will be built and equipped with this system. A number of steam railroad companies have installed also gas electric cars for handling branch line traffic. The cars are usually equipped with a 200 H. P. eight cylinder gasoline engine and two 100 H. P. standard commutating pole railway motors.

A line of Westinghouse direct current motors has been developed for use on 1,200 and 1,500 volts. These will be used on the Piedmont Traction Company's system in South Carolina and the Oakland and Antioch Railway Company of California. The control of the Piedmont Traction Company's equipment of 1,500 volt D. C. cars and locomotives is a modification of the standard Westinghouse design adapted for use on the higher voltages with more switches in series. This company has produced new types of control apparatus for the New York, New Haven, and Hartford Railway Company, and has also developed during the year three types of locomotives for the same railroad, one a shifting locomotive, which operates on straight al-

ternating current and consequently has a simpler control. The New York, New Haven and Hartford Railway Company has now something over 40 electric locomotives in operation.

Railless electric cars have been installed during the past year in the cities of Bradford and Leeds England and it appears that these installations were made after a careful study of the situation at various points on the European continent, where similar installations have been in operation for sometime. The idea has taken such hold in England that during the past session of Parliament provisional orders were granted for the introduction of similar systems in Halifax, Brighton, Aberdale, Botherham, Chiswick, and Northhampton. It is reported that the system offers a great inducement of being able to provide an excellent service at a minimum cost and that the opinion has been formed that this method of conveyance is capable of satisfying the requirements of many districts in England, not already provided for public transfer in a practical and economical manner.

Transmission of Intelligence.

The year 1911 has seen much activity in the telephone industry throughout the country. The development for better telephone facilities in towns and small cities is a striking feature of the year as well as the advancement in the railway field where the installation of telephones with selective ringing features for train dispatching purposes has been particularly active. The telephone is rapidly replacing the telegraph for this purpose and a large number of roads are now adopting it as a standard. A new selector of Western Electric design has been placed in successful operation. Also a selectively operated semaphore is another new development. This device enables the train dispatcher to throw the semaphore and communicate with the train crew when the train gets into the block.

In the field of telephones for the home and factory, the intercommunicating type has made marked progress. Several new Western Electric designs have been developed and these systems can now be secured in sizes to accommodate needs both large and small. In the South where the Western Electric Company is particularly active in the telephone field, this company reports a growing demand for telephone service in towns of from 300 to 500 people and from the farmer. Approximately 15,000 farmers' homes have been equipped with telephones during the past year and during the past few months, over 50 towns of 300 to 500 people have installed telephone exchanges. The railroads in the South where the telephone is rapidly replacing the telegraph and where Western Electric equipment is used are the following: Atlanta Coast Line, Central of Georgia, Seaboard Airline, Georgia Railway, Southern Railway, Florida East Coast.

Southern Developments.

The largest recent and proposed electrical systems and water power developments in the South have been commented upon in another section of this issue and will therefore he omitted at this point. During the past year or so there has developed in the South a marked activity in electrification of industrial plants and this activity is showing itself in a conversion of large textile mills, cement plants, saw mills, fertilizer plants, phosphate plants, cotton oil mills, iron and coal mines. The demand for motor equipment in textile mills varies in regard to sizes from 1 to 200 H. P., 20, 50 and 75 H. P. being the larger and more frequent installations. In cement mills 50, 75, 100 and 150 H. P. drives are used, in saw mills and fertilizer plants a great variety of sizes varying from low power to high and in phosphate plants 50, 100, and 150 H. P. In cotton seed oil mills 50 to 75 H. P.; in iron and coal mines from 32 to 200 H. P. The largest demand seems to be in motors from 50 to 150 H. P. Aside from the textile mill, a conservative estimate places about 50 per cent of industrial plants throughout the South now using electric power either in part or in whole. It is only a few years ago when nearly all industrial plants throughout the South were using steam equipment altogether. These steam plants are, however, constantly considering electric drive and changing their plant either to entire drives or making their additions electrically driven.

In the already existing steam plants of considerable size where additions are necessary in the power equipment, the low pressure turbo-alternator is being favorably considered. Where injector water is available and a sufficient amount of low pressure steam, it is expected that a large demand for this equipment will be felt in the future. At the present time there is a sufficient capacity and number of plants operating this equipment to prove its particular advantage. Already there is about 25,000 K. W. of mixed and low pressure turbines operating in industrial plants in the South. There are in the South over 50 hydro-electric plants of various sizes in operation, including a kilowatt capacity, not including Southern Power Company's plants, of over 300,000. The systems are installed according to the latest in engineering practice and each includes a generating equipment of a voltage varying from 2,300 to 6,600 to 12,500 stepping up by transformers for transmission from 11,000 to 110,000 depending on the length of the transmission system. Of the non hydro-electric plants, the generating voltage varies from 480 to 6,600, with 2,300 most common. The operating voltage of plants varies somewhat according to the conditions, 440,550, and 2,200 being the voltages most used in the industries throughout the South.

As an indication of the demands for various classes of equipment the following list of operating companies of considerable size installing new equipment during the past year is given. Allis-Chalmers gas engines have been installed by the following: Southwestern States Portland Cement Co., Eagle Fort, Texas; Palmetto Phosphate Co., Tiger Bay, Florida; Loomis Utilization Co., Waycross, Ga.; Ware County Light & Power Co., Waycross, Ga.; Swift & Co., Bartow, Ga., The above equipments aggrgeate about 6,000 H. P. Steam turbines manufactured by the same company have been installed as follows: Muskogee Gas & Electric Co., Muskogee, Okla.; Memphis Street Railway Company, Memphis, Tenn.; Rickerts Rice Mills, New Orleans, representing an aggregate horsepower of 9,000. Allis-Chalmers hydraulic turbines have been installed at the plant of the James White Power Company at Athens, Ga., the Florida Power Company, Citronella, Fla., aggregating about 11,000 H. P. Steam turbines have been variously installed throughout the section, twenty of the largest plants installing Allis-Chalmers equipment, totaling an approximate K. W. capacity at normal rating of 42,000 K. W. Further than the above equipment, pumping engines for the various municipal water works

systems have been installed in large capacities and large units.

The following important companies have installed during the past year General Electric steam turbines: The Georgia Railway & Electric Co., Atlanta, Ga.; Charleston Railway, Gas & Electric Co., Charleston, S. C.; Augusta Railway & Electric Co., Augusta, Ga.; Columbia Electric Street Railway Company, Columbia, S. C.; Montgomery Light & Water Power Co., Montgomery, Ala.; The Anderson Water Light & Power Co., Anderson, S. C.; Spartanburg Railway, Gas & Electric Co., Spartanburg, S. C.; The City of Jacksonville, Fla.; New Orleans Railway & Light Co., New Orleans, La.; Shreveport Gas, Electric Light & Power Co., Shreveport, La.; Alabama Fuel & Iron Co., Acmar, Ala.; Alabama Marble Co., Sylacauga, Ala.; Charleston, S. C., Mining & Mfg. Co., Fort Meade, Fla. The equipment installed in these stations, including steam turbines and motor generator sets, aggregate over 25,000 K. W. Central stations of smaller size have also placed considerable busineess during the past year and there has been installed a number of lighting plants in small towns of 1,000 to 1,500 inhabitants. Most of these towns install a generator of from 75 to 150 K. W. capacity.

Prominent among the industrial plants of the South installing large horsepower in General Electric motors are the following: Simpsonville Cotton Mills, Simpsonville, S. C., 500 K. W. turbine and 500 H. P. in motors; Graniteville Mfg. Co., Graniteville, S. C., a 500 K. W. low pressure turbine and 500 H. P. in synchronous and induction motors; Duncan Mills, Greenville, S. C., a complete 2,000 K. W. 11,000 volt transformer substation with 1,600 H. P. in motors; The Alabama Fuel & Iron Co., of Acmar, Ala., two 500 K. W. turbines and 500 H. P. in motors; The Alabama Marble Co., Sylacauga, Ala., a 500 K. W. turbine and 500 H. P. in motors; The G. S. & F. Railway Co., Macon, Ga., 600 H. P. in motors for railway shops; The Kincaid Mfg. Co. of Griffin, Ga., 800 H. P. in motors; The Southern Box & Lumber Co., Savannah, Ga., 400 H. P. in motors; The French Phosphate Co., Fort Meade, Fla., two 300 K. W. and one 1,500 K. W. generator and 600 H. P. in motors; The Panola Cotton Mills, Greenwood, S. C., 100 H. P. in motors; The Ensign Cotton Mills, Forsyth, Ga., 500 H. P. in motors; The Royster Guano Co., Macon, Ga., 500 H. P. in motors. The total equipment of these installations aggregate 6,600 K. W. in generating equipment and 7,100 H. P. in motors. The Georgia Power Company of Atlanta will install three 10,000 K. W. General Electric water wheel driven generators with transformers and five substation equipments, and The Little River Power Company of Jackson Shoals, Ala., will install two 1,000 K. W. water wheel type generators.

The Southern installations of Westinghouse turbines during the past year and of considerable size include, Richard Tillis Power Plant at Montgomery, Ala., with two 2,500 K. W. turbines, two 100 K. W. turbine driven exciter units and two 500 K. W. rotary converters; The Southern Power Company's auxiliary steam plant at Greenville, S. C., and the Greensboro steam plant, each containing 8,000 K. W. maximum rated turbine, direct connected to a generator unit, making an aggregate K. W. of equipment in these plants of over 22,000. The water power developments in which Westinghouse equipment has been installed include the Central Georgia hydro-electric plant near Jackson, Ga., with four 3,000 K. W. water wheel driven units, two water wheel driven exciter units; The Eastern Tennessee Power Plant, near Parksville, Tenn., with four 3,000 K. W. water wheel driven generators and two water wheel driven exciter units; The Columbus Power Company at Columbus, Ga., with two water wheel driven 5,000 K. W. generators, making an aggregate capacity in these stations of 34,000 K. W. in water power equipment.

According to present outlook the business conditions for 1912 are far better than those of the past year. With the Southern Power Company, The Central Georgia Power Co., The Georgia Railway & Power Co., The Chattanooga Power Co., and other large generating systems extending their transmission lines to practically cover the South, the conditions are rapidly improving and electrification in the near future is expected to progress at a rapid rate.

Electrical Developments Abroad During 1911.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY R. E. NEALE, A. C. G. I., B. SC., ENGLAND.

THE European trade depression of recent years appears to be well passed and there is now commencing a period of unparallelled development in the electrical industry. English manufacturers are appreciating at its true value the fierce German competition encountered at home and abroad, and it seems likely that the actions of the National Electrical Manufacturers' Association and others will create closer ties between financiers and electrical manufacturers, such as already exist in Germany. Throughout Europe, complaints are raised of inadequate prices and price-cutting competition. In England, our recent labor troubles seem only too likely to again break out in aggravated form, and there can be no doubt that the lower electrical professional ranks are grossly underpaid.

Exhibitions may now be regarded as a more or less reliable index of the state of the industry they represent, but, in this respect, those held during 1911 have been rather disappointing. The Olympia Exhibition, though excellent in many respects, was far from representative of the industry. Exhibits at Turin did poor justice to our manufacturers and the great government supported exhibition at Allahabad seems to have been chiefly remarkable for the lavish distribution of awards.

CENTRAL STATIONS AND PRIME MOVERS.

The extension of central stations proceeds with extraordinary rapidity, and on every side there is a continuous

replacement of plant with the latest machinery. The Electricity Supply Publicity Committee is doing good work, but greater co-operation between stations is needed, together with a more vigorous style of publicity matter. To quote a few typical instances of development, the demand at Greenock is 2,000,000 kw. hrs. annually, and at Sheffield, the connected load is increasing at the rate of 2,000 kw. per annum. A new station of 40,000 kw. capacity will be required at Liverpool within two or three years and at Birmingham, the maximum capacity of the undertaking is being brought up to 33,500 kw., and 17 acres of ground has been purchased for a $1,250,000 high tension station. The large storage battery recently installed at Manchester has fully realized its expected advantages.

Among the large turbo-generators now in use the following may be mentioned: A 5,000 kw. Rateau at Greenwich; 5,000 kw. Westinghouse impulse turbine at Motherwell, N. B.; 6,000 kw. Zoelly at Manchester, and 6,250 kw. Parsons at Newcastle. A third 3,000 kw. unit is being installed at Bradford; a 2,500 kw. unit at Stalybridge, and four 1,600 kw. units at Salford. In smaller stations, units of 500 kw. and thereabouts are being freely installed. There is a wide field for the mixed pressure turbine in colliery and similar work, and considerable economies have been realized at Glasgow by the use of this type.

The Northeastern power scheme now covers an area exceeding 1,000 square miles and supplies about 150,000 horsepower to collieries, shipyards, railways and general industrial works. In South Wales, horizontal, tandem blast furnace engines are in satisfactory use. In Manchester 1,350 horsepower horizontal tandem engines with built-up cylinders are being built, and at the Festival of Empire, (London), there are two 1,000 horsepower vertical, four crank, eight cylinder National engines running on town gas. In painful contract to these advances comes the conclusion of the suit against the Johannesburg gas-electric station contractors. The failure of this ill-fated scheme (1906) was a tragedy of over-optimistic pioneering in an outlandish spot, with insufficient experience and in face of an extraordinary series of accidents. A similar instance of the rash application of untried plant is to be found in a small Norfolk town, where 600 kw. of suction gas plant has rusted since 1899, while a Bellis and Morcom steam plant does its work.

ELECTRICAL MACHINERY AND APPLICATIONS.

A very noticeable development in the field of dynamo-electric machinery has been the introduction of vertical shaft machines for various duties, that is, motor-generators for searchlight supply, vertical motors enclosed in capstan heads, the A. E. G. vertical motor for general belt driving of vertical shafts and so on. The Barbour homopolar dynamo, yielding from 500 amps. at 100 volts to 6,000 amps. at 8 volts, was a feature of the Olympia Exhibition. In efficiency, weight and general practicability, this machine possesses many advantages over earlier types.

The industrial use of electric motors is ever widening, and we are hardly as backward in this respect as many of your writers avow. The latter attach insufficient importance, in many cases, to the high efficiency and excellent condition of much of the steam plant in use; factors which prohibit its abolition on economic grounds.

The wide use of electric motors is of the greatest assistance to private and legislative smoke abatement work. From 1901-2 to 1909-10 there was an average of 10.6 foggy days and 93.5 hours of bright sunshine per winter, as compared with 20.7 days of fog and 70.1 hours of sunshine during the corresponding preceding period. (London data.) Electrical apparatus is used to an extraordinary extent on all our latest warships and persistent small scale experiments are being carried out concerning the practicability of electric ship propulsion. The "Electric Arc" carries a 45-horsepower, 4-cylinder Crossley engine, running on producer gas and driving the propeller through a Mavor electrical transmission.

The mushroom growth of moving picture theatres has created a new class of central station consumer. The halls running continuous performances in large towns are welcome loads, but in smaller undertakings the electric theatres accentuate the peak load. In Bury, four halls are supplied by a special main and thus disturb one another rather than the ordinary consumers. The comprehensible, but mistaken attitude of tolerant contempt hitherto assumed by electrical engineers towards the electric heater and cooker, is rapidly vanishing. Among the apparatus at present available, the Bastian quartz enclosed room heater and the Therol superheated steam cooker and water heater find very wide favour. The Therol apparatus possesses that invaluable merit from the central station standpoint, of 100 per cent load factor.

Widespread experiments with electricity in agriculture are being conducted, with uniformly striking results. The Board of Agriculture makes a small annual subsidy, (soon to be increased), to the Bristol University for its researches in this direction. The great difficulty still is to devise a cheap system which shall be suitable for use in the hands of the average agriculturist.

ELECTRIC TRACTION.

Very few particulars of the working of the L. B. & S. C. Railway electrified line have yet been published, but there is good reason to believe that the maintenance costs are rather heavy. Arcing at the bows of the running trains provides a splendid and fairly continuous pyrotechnic display. A new recorder, registering the miles run with and without current and braking has lately been installed and a bonus is given to drivers according to results, and considerable energy economies have thus been effected. The electrification of the East Kent line has passed its preliminary stages. The Central London tube railway is being extended from the Bank to Liverpool St. at a cost of $1,250,000, and the extension will be opened to traffic next autumn.

A proposal is on foot for 4¼ miles of tube railway in Manchester. A bill sanctioning a $5,000,000 scheme is to be promoted next session. A 16-ton, 45-passenger, 20-M. P. H. petrol electric train has been tried on the G. W. Ry. and here, as on the Continent, has proved its suitability for branch line working. Experiments are still being conducted by the North British Railroad and at Glasgow with turbo-electric locomotives, (travelling central stations), but it is too early to estimate the potentialities of these engines. Electric ticket-printing and issuing machines have been installed on the Liverpool & Southport Railway and on certain Continental lines, with satisfactory results.

No startling developments have transpired in the electric tramway field, the surface contact system seems to be finally despatched by the "G. B." contretemps in London. If by no other consideration, this system is doomed by the lateness of its birth. The railless trolley system is now in use in several towns and, if there successful, its use will at

once be extended to many low-traffic routes. In Leeds and Bradford, trolley-busses are fitted with 2-20 horsepower motors and carry 28 passengers. The cost of the busses equals that of single-truck tram cars and of the overhead system averages $6,250 per mile. The traffic realized on the Bradford system has, so far, fallen short of expectations. Petrol-electric private and public vehicles continue to make good progress, but the purely electric vehicle is still of very restricted development.

ELECTRIC LAMPS AND LIGHTING.

The development of flame arc lamps proceeds steadily but is almost overshadowed by the phenomenal advance of metallic filament types. It is inexplicable why the Mazda lamp should have been so long in crossing the Atlantic, but there can be no doubt that the superiority of the drawn-wire filament is now generally realized. Coupled with the recent wholesale reduction in prices of metal lamps, comes the announcement that Osram and Wotan lamps will henceforth employ drawn filaments exclusively. The introduction of Intensive Osram lamps consuming 0.8 watt per hefner candle power is worthy of mention. Unsatisfactory reports of the Moore lamp come from Germany and, in this country, the lamp finds no favor. On every side one sees the substitution of metal lamps for gas lamps, enclosed and open arcs in street lighting, where the high candle power of the flame arc is not justified. In London alone from 15,000 to 17,000 gas lamps have been so converted during recent years. Flame arcs yielding 3,000-4,000 candle power, with a current consumption of 10 to 12 amps., are freely used in all large towns and, in the smaller streets, metal lamps of from 50 to 400 candle power are used according to needs. A considerable number of 1,000 candle power metal lamps are already in use.

A curious feature of the recent improvements in the street lighting of the London Borough of Holborn is the acceptance of a joint tender by a gas and electric company. During the Coronation festivities, especially favorable rates were quoted by most central stations for the supply of illuminating schemes and many firms showed great enterprise in evolving artistic devices for their own or market use; needless to say, electric lamps were used in far greater number than gas burners.

DISTRIBUTION AND WIRING.

Cheap but substantial overhead lighting lines are now in use in a number of Welsh towns and in Worcester, to cite only cases coming under the writer's own observation. The new I. E. E. wiring rules are much relaxed in severity, particularly as regards permissible current density. Though conforming to the new rules, certain of the smaller conductors such as 18 S. W. G. may carry as much as 12,000 amps. per square inch before their protecting fuse blows. Too much appears to be left to temperature rise and voltage drop limits and the rules find many dissentients. The Phoenix Insurance Co. adheres to its own old rules, which are very stringent.

TELEGRAPHY AND TELEPHONY.

The efforts of the Imperial Conference to secure reduced cable rates between various parts of the Empire seem likely to bear good fruit and the combine of certain of the Atlantic cable companies will certainly make for efficiency and economy of service without involving any of the usual objections to trusts. There are now some 400 Telwriter instruments in use in London and about 150 subscribers to the Telwriter Exchange, (using the Post Office wires). The value of this exchange is rapidly increasing as the number of subscribers rises.

In addition to ever-increasing message traffic, wireless telegraphy is now applied to a number of duties which could be served by no other means. The Eiffel Tower station, which is now in working connection with Canada, sends out time signals twice daily.

General Electric Atlanta House Gives Annual Dinner.

On Saturday evening, December 16th, the General Electric Company's Atlanta house gave the annual banquet to its salesmen at the Capital City Club. A most enjoyable evening was spent, in which about one hundred and ten representatives and guests participated, many coming to Atlanta from distant points especially for the occasion. Mr. A. F. Giles, general manager of the Atlanta house, ably officiated as toastmaster, calling upon a number for appropriate toasts. Judge H. E. W. Palmer was assigned the topic of "Things of the Past." To this toast he gave a most interesting talk on the early electrical development of Atlanta, reviewing the efforts of the Thomson-Houston Company in introducing electricity into the city. Judge Palmer secured the franchise for the above company to carry on electrical activities in Atlanta, and became their first local manager, opening offices in a small store near the present Kimball House. After a hard fight against city authorities, Judge Palmer succeeded in introducing electric lights in Atlanta, starting with one Thomson-Houston arc machine and operating forty arcs. Mr. P. S. Arkwright, president of the Georgia Railway & Electric Co., was next called upon to respond to "Present Developments." His remarks were particularly fitting as an expression of the nature and extent of electricity in Atlanta at the present time. He outlined the commercial policies which have and will make the development more complete in the future. Mr. W. T. Gentry, president of the Southern Bell Telephone Co., next responded to "Hello People." Since Mr. Gentry is one of the oldest electrical men in Atlanta who has been through all its developments, his remarks on telephone activities were suggestive of the growth and extent of Atlanta's present telephone system. Mr. J. J .Spalding, of the recently formed Georgia Railway & Power Co., in responding to "Capitalizing the Horsepower of an Electrical Development," was loudly applauded. His remarks were particularly interesting, as some reference was made to his efforts in behalf of the Georgia Railway & Power Co. before the Railway Commission, in which he was endeavoring to secure an order for stock and bond issue to carry out our future developments.

Mr. T. F. Wickham, of the Central Georgia Power Co., responded to the topic "We Want Atlanta." This subject was particularly appropriate on account of the recent activity of the above company to sell the city of Atlanta current from their development at Jackson, Ga. Mr. Wickham handled the matter in appropriate terms. Mr. Forrest Adair, who is especially interested in Atlanta real estate, responded to "Lots and Lots of Things" in a way that brought tremendous applause and slated him as a most public-spirited Atlanta citizen, as well as an orator.

Dr. W. M. Franklin, of the General Electric Co., secured the highest score of the evening in his response to a scientific talk on ozone. While his remarks were scientific and descriptive of his subject, they were most humorous

and highly enjoyed. Mr. W. M. Stearns, manager of the supply department of the Atlanta house, closed the speaking by a review of the General Electric sales work during the past year, and commented upon features which had made the past year the best in the history of the Atlanta house. After Mr. Stearns' talk, a unique feature of the evening was introduced by each group of college men present responding to the name of their college by the college yell.

The following are the representatives and their guets at the banquet: Representing General Electric Co., A. F. Giles, district manager; W. M. Stearns, manager supply department; B. Willard, J. H. Clark, G. E. Richardson, G. W. Peabody, Dr. M. W. Franklin, W. E. Hannum, M. A. Ladd, W. L. Barker, G. N. Brown, G. W. Moore, J. D. Myrick, J. M. Anderson, F. C. Williams, L. W. Carnagy, P. A. Weeks, J. B. Anthony, J. P. Dava, E. F. McLaughlin, L. Callender, H. W. Key, E. H. Ginn, H. M. Powell, T. R. King, H. E. Bussey, W. C. Coles, J. T. Kerns. From Schenectady: M. O. Troy, C. A. S. Howlett, W. F. Howe, H. Bickerstaff, A. W. Henshaw, E. H. Anderson. From New Orleans: C. B. Mahaffey, C. P. Tucker, D. S. Clifford, J. E. Sims. From Charlotte, N. C.: Edward Clark, Jr., E. P. Coles. From Birmingham, Ala.: R. A. Riley, G. O. Hodgson, R. T. Brooke. From Macon, Ga.: C. N. Rackliffe. From Chattanooga, Tenn.: O. F. Whitehurst. From Jacksonville, Fla.: G. C. Henry. From Columbia, S. C.: H. S. Roberts.

Guests: Representatives of the Georgia Railway & Power Co.: Forest Adair, J. J. Spalding, H. B. Broughton, L. F. Joerissen, C. E. Parsons. Representatives of Georgia Railway & Electric Co.: P. S. Arkwright, G. W. Brine, W. R. Collier, A. M. Moore, J. T. Chambers, S. A. Redding, W. H. Shaw. Representatives of Western Electric Co.: E. J. Wallace, T. A. Burke. Representatives of Southern Bell T. & T. Co.: W. T. Gentry. Central Georgia Power Co.: L. A. McGraw, T. F. Wickham. Columbus Power Co.: J. S. Bleecker, G. K. Hutchings, C. M. Young. Rome Railway & Light Co., Rome Ga.: W. A. Ford, H. J. Arnold. Carolina Light & Power Co., Aiken, S. C.: H. Sudlow. Anniston Electric & Gas Co.: R. L. Rand. Fort Wayne Electric Co., New Orleans: E. G. Kellar. Fort Wayne Electric Co., Atlanta: S. H. Smith, Jr.. Perry-Mann Electric Co., Columbia, S. C.: W. M. Perry, M. L. Mann. Atlanta Steel Co.: J. Z. Collier, T. Girdler. B. F. Sturtevant Co.: G. R. McNamara. J. G. Brill & Co.: F. L. Markham. J. B. McCrary & Co.: W. M. Sambro, J. B. McCrary. The City Electrician, Albany, Ga.: L. Von Weller. International Agricultural Corporation, of Atlanta: L. P. Foster. Sprague Electric Co., Atlanta, Ga.: F. H. Hill. Green Fuel Economizer Co.: H. Clay Moore. Lockwood, Greene & Co.: R. A. Thayer, E. Y. Wooten. Harrisburg Foundry & Machine Works: R. B. Hall. Pratt Engineering & Machine Co.: G. L. Pratt. Howard & Bullough Machine Co.: E. Chappell. Gate City Cotton Mills: S. A. Carter. Piedmont Cotton Mills: B. L. Willingham. Seabrooke & Howard Co.: E. M. Seabrooke, R. O. Howard. Massachusetts Cotton Mills: H. P. Meiklehan, of Rome, Ga. Georgia Cotton Oil Co.: W. M. Schroder. W. R. C. Smith Publishing Co.: W. R. C. Smith. Southern Electrician: C. S. McMahan, D. H. Braymer.

Of Atlanta: Dr. W. S. Elkin, Judge H. E. W. Palmer, E. Woodruff, J. N. Eley, F. D. Milstead, John Hill, W. B. Bloxham, S. D. Pickett, Robt. L. Greaves.

GENERAL ELECTRIC REPRESENTATIVES AND GUESTS AT BANQUET.

Reading left to right from rear left corner room: Dr. W. S. Elkin, H. P. Meikleham, H. P. Broughton, Forrest Adair, J. J. Spalding, P. S. Arkwright, A. F. Giles, Judge H. E. W. Palmer, W. T. Gentry, E. J. Wallis, H. Clay Moore, W. J. Tilson, T. F. Wickham, Ernest Woodruff, T. A. Burke, W. M. Schroder, B. Willard, J. H. Clark, G. E. Richardson, G. K. Hutchins, E. Y. Wootten, R. B. Hall, G. L. Pratt, J. N. Eley, D. W. Peabody, R. A. Thayer, F. D. Milstead, E. Chappell, S. A. Carter, B. F. Willingham, John Hill, R. O. Howard, Dr. M. W. Franklin, E. M. Seabrooke, M. O. Troy, W. R. Collier, J. S. Bleecker, W. M. Stearns, C. M. Young, C. A. S. Howlett, W. E. Hannum, M. A. Ladd, G. C. Henry, W. L. Barker, Edward Clarke, Jr., G. N. Brown, R. A. Riley, J. E. Sims, T. W. Moore, W. H. Smaw, J. D. Myrick, J. M. Anderson, D. H. Braymer, H. Bickerstaff, C. S. McMahon, A. W. Henshaw, C. N. Rackliffe, L. A. MaGraw, F. T. Williams, C. B. Mahaffey, C. B. Tucker, C. S. Clifford, W. F. Howe,, L. W. Carnagy, P. A. Weeks, J. V. Anthony, J. C. Vava, E. F. McLaughlin, W. A. Ford, G. O. Hodgson, H. J. Arnold, L. Von Weller, H. Sudlow, L. Callender, W. M. Perry, H. S. Roberts, M. L. Mann, H. W. Key, J. Z. Collier, G. R. McNamara, T. Girdler, E. H. Ginn, G. W. Brine, F. L. Markham, E. H. Anderson, A. M. Moore, L. F. Joerissen, W. M. Fambro, S. H. Smith, Jr., J. B. McCrary, H. P. Powell, T. R. King, L. P. Foster, W. B. Bloxham, J. T. Chambers, H. E. Bussey, S. A. Redding, C. E. Parsons, R. L. Rand, W. C. Coles, T. W. Peters. J. T. Kerens, S. D. Pickett, Robert W. Greaves, F. H. Hill, R. T. Brooke, W. R. C. Smith, E. P. Coles, O. F. Whitehurst, E. D. McKellar.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

TEST ON ROTARY CONVERTER.

Editor Southern Electrician:

(264) I desire to make tests on a 300 K. W. rotary converter as follows: One test running from the D. C. end to determine the ratio of the converter and its variation. The other to get the operating characteristics of the machine when running from the A. C. end. Are there any standard regulation methods of performing these tests and any precautions to take in order to get exact data? I would be glad to get a diagram of the best arrangements by testing circuits to check my own against. Give connections from 440 A. C. supply through transformers to 150 volts at rotary. The D. C. end delivers 240 volts. H. A. B.

VOLTAGE AT CENTER OF DISTRIBUTION.

Editor Southern Electrician:

(265) Kindly ask your readers to submit the method of calculating the voltage at the center of distribution of a system and illustrate the method for the following case: Take a 2,500 volt, 3-phase, 3-wire circuit with the entire load at a distance of two miles from the plant. The currents flowing in the lines are, 90 amperes, 110 amperes, and 138 amperes. The size of wire is 4-0, and spacing of conductors 24 inches. What will the voltage be between lines, A-B, B-C, and A-C at the load. Kindly show the method for 100 and 70 per cent power factor load across each phase. P. E. P.

SIZE OF MOTOR FOR SMALL AIR COMPRESSOR.

Editor Southern Electrician:

(266) I would like to know if there is a standard formula for determining the horsepower required to drive an air compressor. I have to determine the size of electric motor best suited for a single cylinder, 3 x 4 inches, air compressor, operating at 200 R. P. M. for a pressure of 100 pounds. Kindly give method and explain.

E. T. C.

QUALIFICATIONS FOR ILLUMINATING ENGINEER.

Editor Southern Electrician:

(267) What information and data should the electrical engineer possess to undertake the intelligent layout of a lighting system, say for an office building?

L. A. L.

DESIGN OF SOLENOID.

Editor Southern Electricians

(268) The writer would appreciate advice as to how to solve following problem: Required a solenoid which will lift 4 to 6 ounces, the core to be 5/16 inches iron and move 3/16 inch, coil to be ¾ inch in diameter and 1¼ inches long. The dimensions may be changed slightly if necessary. I desire size of wire to use for most efficient results on four No. 6 dry cells. Also on 110-volt circuit. Coil will never be on circuit more than ten minutes at a time, and then only intermittently. Should tube be pluged with iron at upper end? G. J. K.

WHAT IS A 2 TO 1 MOTOR DRIVE?

Editor Southern Electrician:

(269) The writer has been advised that for a plainer in a machine shop required to do work of a varied nature, a 2 to 1 motor drive is best suited. Kindly explain through your columns whether or not the 2 to 1 refers to a gear connection to the machine, with variable speed motor or to the speed range of a variable speed motor, or to both. What determines this ratio? F. C. M.

WINDING FOR INDUCTION MOTOR.

Editor Southern Electrician:

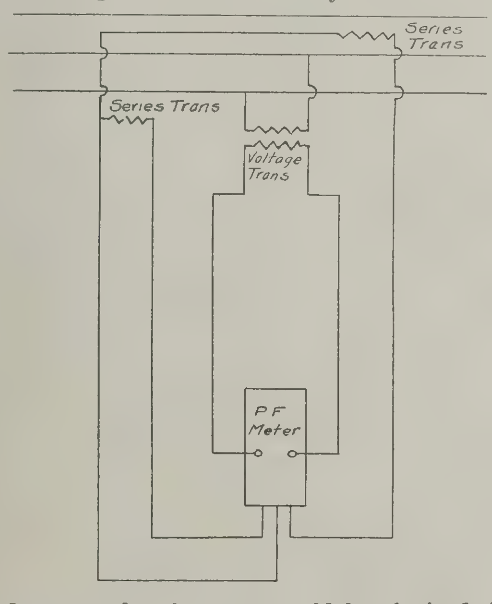
(270) I would appreciate information and a diagram showing how to rewind a single-phase induction motor of the following description: 24 stator slots; 19 rotor bars; 110 volts; 2,000 R. P. M.; ⅛ horsepower to operate on 60-cycle, single-phase line.

J. P. L.

CONNECTIONS FOR POWER FACTOR METER.

Editor Southern Electrician:

(271) I present herewith a diagram of the back of the Westinghouse type I edgwise power factor meter, with connections. Owing to the fact that only about one-twentieth



full load current for the meter could be obtained, it was impossible to be guided by the calibration mark, which requires one-fourth full load current. Are the connections correct? Also, please explain how to determine the proper connections under conditions named above. C. H.

Discussion on Ground Detectors, Ques. No. 159.

Editor Southern Electrician:

In perusing several back issues of SOUTHERN ELECTRICIAN recently, I came across what I believe is an error regarding ground detectors. This was in Mr. H. H. Boyle's answer to Question 159 in your October, 1910, is-

sue. In the diagrams and description no mention was made or nothing indicated fuses in the leads from the generator bus-bars to the detector lamps. The National Electric Code requires that the wires from the bus-bars feeding these lamps should be not smaller than No. 14 gauge and should be protected by fuses. Where the voltage is not in excess of 125, Edison plug fuses of 2 or 3 amperes capacity are generally used. For 220 volt system enclosed cartridge fuses are used. Open link fuses may be used if the floor and surroundings are not combustible. Instead of Fig. 1, which appeared in the SOUTHERN ELECTRICIAN, the connections in Fig. 2 herewith conform to rules. Omission of the fuses in the lamp circuit might

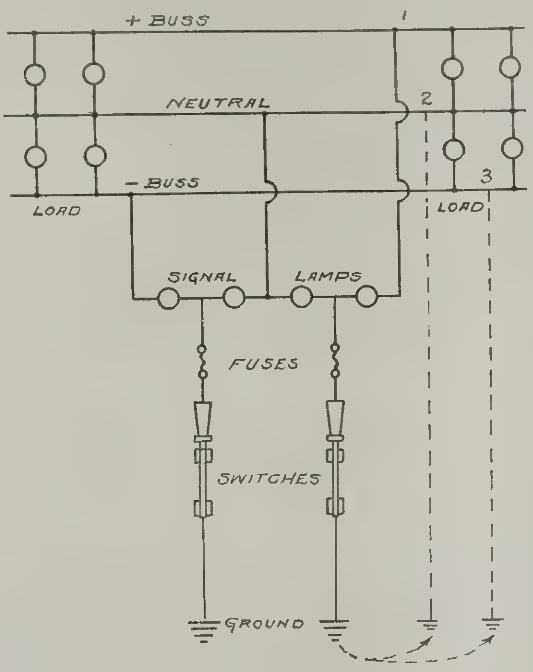
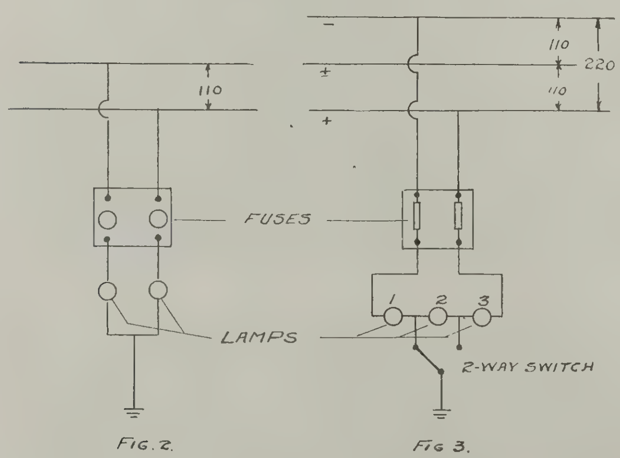


FIG. 1. INCORRECT GROUND DETECTOR DIAGRAM,

cause trouble to the generator, in case of a short circuit of the leads to the lamps. It is not desirable to have a fuse in the ground wire, as shown in Fig. 1. Heavy grounds might blow this fuse and open the connection to the ground and cause a false sense of security. Both detector lamps would burn with the same degree of brightness and a ground of some part of the system would not be indicated, because of the break in the ground wire caused by a blowing of the fuses.

In the ground detector diagram for the three-wire sys-



FIGS. 2 AND 3. CORRECT GROUND DETECTOR SCHEMES.

tem in Fig. 1, reproduced as shown in the article mentioned, a ground at points 2 and 3 would indicate in the same way, as shown by the dotted lines, that is, both would cause the same brightening or dimming in the same lamps. For a ground detector used with a three-wire system, my diagram Fig. 3, shows the use of a two-position switch, by means of which it is possible to ascertain whether the ground is on the neutral or on one of the outside wires.

GEO. J. KIRCHGASSER.

Delta vs. Y Connections, Ans. to Ques. No. 236.

Editor Southern Electrician:

I have read with interest the discussions on the above subject in your September, October and November issues. The discussions leave little to be said in regard to the general arrangements and theory. However, by referring back to the original question, I believe that the following may bring out the points in question a little more definitely.

Delta to delta connection is generally preferable to Y. to Y. connection when using ordinary single-phase transformers. For a certain maximum load for the transformers in delta to delta connection, they would be overloaded and probably burned out when connected Y. to Y. In stating that the motor would receive $1/\sqrt{3}$ of its rated voltage the questioner is mistaken. The primary coils would receive $1/\sqrt{3}$ of the primary line voltage, the secondary coils $1/\sqrt{3}$ of their rated voltage, but the secondary line voltage, which is the voltage motor receives, would be the vector sum of the voltage of the secondary coils, making line voltage normal.

Now in respect to the current, the line current in Y. connection would be the same as the secondary coil current, and assuming that the normal coil current is 1, the line current would be 1 where it should be 1.732 to compare with delta operating conditions. In other words, to supply full line current the secondary coils would be 73.2 per cent overloaded.

W. M. HAYES.

Combined Cost of Power and Lamp Renewals, Ans. to Ques. No. 254.

Editor Southern Electrician:

In reply to question 254, the following is given: A standard 40 watt, small bulb, Mazda or tungsten lamp, gives 32.5 mean horizontal candle power. However, since the candle power in other directions is not so great as in a horizontal direction, the mean spherical candle power is not as much, being only 25.4. The mean spherical candle power is 79.1 per cent of the mean horizontal, this value being known as the spherical reduction factor. In referring to candle power, or candle hours, care should be taken to specify which is meant. Formerly the mean horizontal value was the standard, but the mean spherical value is coming to be more used, especially in comparing different types of lamps. Still a better and less ambiguous way is to express the light giving value in terms of the total flux or quantity of light which is expressed in lumens, and is entirely independent of the direction in which the light is thrown. A light giving one mean spherical candle power has a total flux of 12.56 lumens. The flux of the 40-watt light under discussion is, therefore, 319 lumens.

The cost of the light may be given in terms of 1,000 hours burning, or per 1,000 candle hours, which is the equivalent amount of light which would be given by one

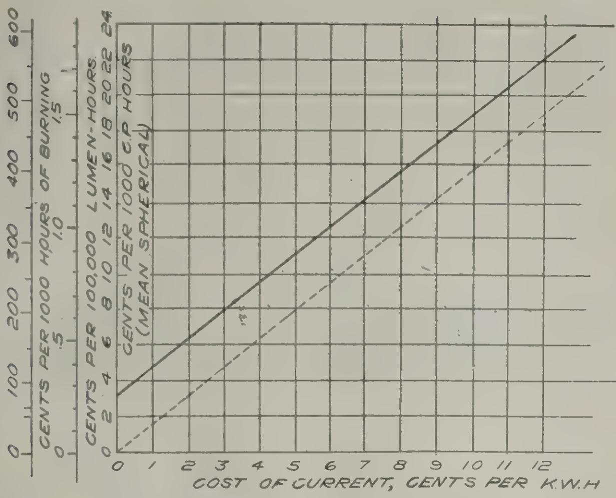


FIG. 1. COST OF CURRENT AND RENEWALS FOR A 40-WATT LAMP.

candle power for 1,000 hours, or per 100,000 lumen-hours, which is the light which would be given by one lumen in a period of 100,000 hours. The first of these is not very satisfactory, as the values obtained are only applicable to that particular lamp, and cannot be used in making comparisons between different sizes or kinds of lamps.

The following curve Fig. 1 gives the total cost of current and lamp renewals for a 40-watt lamp, with different costs of electricity per K. W. H. The price of the lamps is taken at 63 cents, which is standard package price, and the life estimated at 800 hours.

Why Did Fuse Blow? Ans Ques. No. 255.

With the information given, the exact cause of this phenomenon cannot be positively stated. It appears that the engine is shut down with all lights on. We know that the impedance or the resistance to the current flow of an inductive circuit, is produced by the joint action of the ohmic resistance and the reactance, or the countervoltage dependent upon the reversal of the current. The relation is as follows: The impedance is the square root of the sum of the resistance squared and the reactance squared or in symbols, $Z=(\sqrt{r^2+x^2})$. This reactance is equal to 6.28 times the frequency in cycles per second times the co-efficient of self-induction, which again is dependent upon the turns and nature of the magnetic circuit, etc. That is the reactance is, $x=6.28\times fL$.

Now in the case of a transformer, the ohmic resistance can be practically neglected. It follows that if the transformer in question, which takes probably only about one-half ampere of magnetizing current, were put on a direct current circuit, it would practically short-circuit the line, drawing many times the current that it does on A. C. This suggests the possibility that as the engine comes to rest, the voltage is lowered and so is the frequency, and the transformer reactance may finally be so low that the current taken may be so great as to blow the fuse. This matter may easily be tested, by opening the main switch and cutting off the lights before shutting down the engine. If the above is the case, this will be found to be a remedy. I should be glad to know from the questioner if this proves effective. A. G. RAKESTRAW.

Single Phase vs. Three-Phase Motors, Ans. Ques. 256.

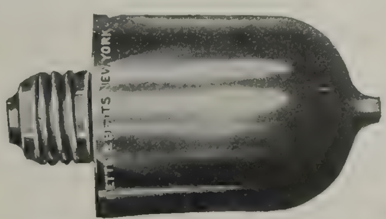
Editor Southern Electrician:

In reference to the advisability of installing single-phase and three-phase motors in answer to question 256 in the November issue, I beg to advise that conditions largely determine this matter. In the case referred to, where single-phase and three-phase distribution is available, it is of course advisable to install single-phase motors at points where new lines have to be constructed a considerable distance. It is the general rule for the central station to construct the line, furnish meter and transformer, while the customer buys the motor. It will therefore be seen that the single-phase motor is much cheaper in these cases. While the expense of the single-phase motor for the customer is a little greater, it is not enough to make any difference, and he usually will not object to its use. A five horsepower, single-phase motor is usually considered the most economical size of motor to use. In all cases where a three-phase distribution system is near the customer, three-phase motors should be used. H. F. BOYLE.

New Apparatus and Appliances.

A New Betts & Betts Color Cap.

The Betts & Betts Company, of 306 West 53rd Street, New York City, has recently placed on the market a new color cap for use with electric signs. This cap differs from those heretofore offered by the above company in that it covers the whole lamp. The new cap will be known as style B color cap, and will snap on the lamp in the same manner as other color caps made by the company, there being no metal holders, rubber rings, washers or other attachments necessary. This cap has been developed for use on electric signs where the background is not colored, as is necessary for style A cap. It permits the changing of colors on the sign frequently without repainting the background, making it especially adaptable for special decorations. It can also be used to very good advantage for window decorating, stage lighting, streamers, etc.

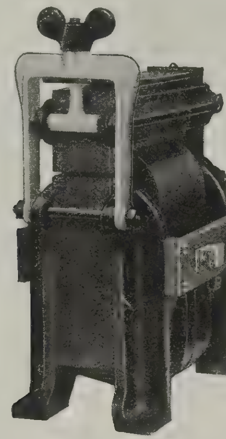


BETTS & BETTS COLOR CAP.

Thordarson's Step-up Transformers.

The use of the small high potential transformer for commercial purposes is increasing continuously in electrical factories, whether they are small or large, for testing their product. The illustration presented here represents a type of transformer that answers all the requirements for com-

mercial use. It is small and compact, and all parts are exposed. The transformer is designed to be run continuously, if necessary. It is constructed with a magnetic shunt and equipped with a regulating device to give instant adjustment. No impedence coil or other resistance is necessary, and it is designed to connect to any alternating current circuit. These transformers consume no more current than is absolutely required to produce the best



SMALL STEP-UP TRANSFORMER.

results at the desired regulation; in other words, they are self-regulating as far as the current consumption is ocncerned. When more power or capacity is desired simply turning the thumb screw enables this to be accomplished. This transformer may be used for generating ozone, testing insulation, electrostatic separation, wireless telephone and telegraphy, etc., and is manufactured by the Thordarson Electric Mfg. Company, 219 South Jefferson Street, Chicago, Ill.

A New Renewable Cartridge Fuse.

Since the advent of cartridge enclosed fuses a number of years ago, there have been a number of attempts to construct a product of this nature which would possess the necessary electrical characteristics and at the same time be renewable at a very low cost. This work is highly commendable, since the continual replacement of a complete cartridge fuse, especially in places where fuses are blown frequently, materially increases the maintenance expense of the equipment. The Economy Fuse & Mfg. Co., of Pittsburg, appreciating that the electrical performance of a device of this kind was of primary importance, conducted extensive laboratory exeriments with a view to determining the physical properties of the elements involved, and have recently placed on the market a successful renewable cartridge fuse with safe and proper ratings.

The mechanical construction of the renewable cartridge fuse designed and manufactured by this company is shown in Fig. 1, and involves features not common to previous products. One of the primary features, aside from the ease of renewing without making any soldered joints, is the fact that the active fuse element is brought into direct and positive contact with the copper blades at the end, the copper blades being held parallel and in

FIG. 1. RENEWABLE CARTRIDGE FUSE.

proper position at all times by a very simple and unique construction. The fibre shell is constructed of the very best grade of gray horn fibre, the highest class of this material obtainable.

As the electrical characteristics of a product of this nature are of primary importance, the above company has paid particular attention to the development of a proper fuse element, shown in Fig. 2, which would not only conform with the ratings of the National Board of Fire Un-

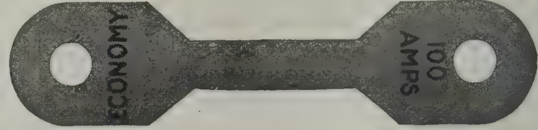


FIG. 2. THE FUSE ELEMENT.

derwriters, but which would not burn up or blow up the shell under every day service conditions. It is claimed that this is the first renewal cartridge fuse ever offered to the trade under a manufacturer's guarantee that it would perform in accordance with the Underwriters ratings, and the company reports that some of the largest factories, office buildings, mills and railroad companies, after extensive laboratory and service tests on renewable cartridge fuses of various makes, have adopted this product as their standard.

Methods of Connecting Wires to Terminal Lugs.

BY H. B. LOGAN.

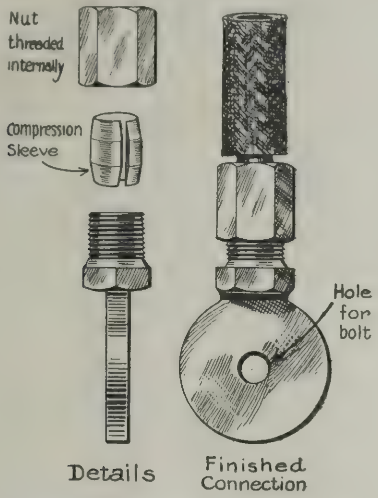
A careful analysis of the article by Mr. H. D. George in the issue of Nov. 4 of the *Electrical World* seems to leave much to be desired in the essentials of convenience and time-saving. The article in question is in the section devoted to "Wiring and Illumination" and is entitled "Methods of Soldering Wires in Terminal Lugs." The first method described requires the following separate and distinct operations: (1) To have or procure a plumber's furnace; (2) to get it ready for use; (3) to melt a pot of solder; (4) to cut insulation from end of conductor and brighten end by scraping or sandpapering; (5) to smear the bared end of conductor with soldering flux; (6) to tin it by plunging it into solder pot; (7) to knock off surplus solder; (8) to push conductor into hole in lug; (9) to souse lug with wet waste to cool it; (10) to scrape or file off shreds and globules of solder; (11) to brighten surfaces of lug with fine sandpaper.

Contrasted with the foregoing, another method of connecting wires to terminal lugs is to use the Dossert solderless connectors, which eliminate entirely the use of solder and require only the following operations: (1) Cut insulation from end of conductor and brighten end by scraping or filing; (2) push conductor into hole in lug; (3) tighten up nut with wrench.

A comparison shows that the soldering method requires the following adjuncts: Plumber's furnace and means for heating same, solder, soldering flux, wet waste and sandpaper, whereas to connect up the Dossert lug requires nothing but a jackknife, a file and a wrench. The saving in time, labor, materials and cost is increased by the fact that soldering operations usually require a man and a helper, while a Dossert joint can be made by one man, no matter how large the cable.

As shown in Fig. 1, the shank of the Dossert lug is threaded externally while the hole is tapered. The com-

pression sleeve is tapered at both ends and slotted longitudinally. The nut is threaded internally and is tapered at the outer end. When the conductor is thrust into the lug and the nut is tightened up the action of the tapers and slotted sleeve exerts a pressure on the cable or conductor of several thousand pounds to the square inch, according to size, thereby making good electrical contact.



DOSSERT SOLDERLESS CONNECTOR.

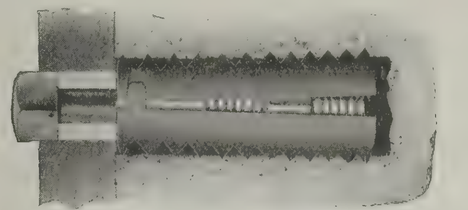
At best a soldered joint is unreliable. Tin, for reasons unknown, very often changes its structure and becomes crystalline, and in turn affects all other metals that it comes in contact with in a similar manner. This may be the reason why cables often drop out of lugs into which they have been soldered. A Dossert lug will not heat as much as the cable which it connects when the cable is heavily overloaded.

Wagner and Century Patent Suit.

The United States Circuit Court of Appeals of the Eighth Circuit, sitting at St. Louis, Mo., in the case appealed from the Circuit Court of the United States relative to the infringement of three letters patent, granted to Ludwig Gudmann for single phase, alternating current motors, has reversed the decision of the Circuit Court and dismissed the complainant's bill. It will be remembered that the suit is one brought by the Wagner Electric Mfg. Co., and others against the Century Electric Co. and Edwin S. Pillsbury, alleging that the Century single-phase motor infringed the Gudmann patents. In the lower court, the complainant secured a decree (no opinion being handed down) and the defendants appealed, with the result as mentioned above.

The Standard Expansion Bolt.

An announcement has recently been made by Mathias Klein & Sons, of Chicago, Ill., to the effect that the company has undertaken the distribution of the Standard expansion bolts. This article has merits to commend it to serious consideration as a stock to be regularly carried, and



STANDARD EXPANSION BOLT.

the company offers a complete stock to the trade. A booklet, "Arguments for the Standard Expansion Bolt," has been published descriptive of the product and copies will be mailed for distribution to sales forces of organizations interested. The bolt is made in standard sizes and is a practical one for hanging awnings, fire escapes, sprinkler pipes, shaftings, signs and every class of material to be fastened or hung to brick, stone, marble, concrete or cement.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

BIRMINGHAM. The city council has received a proposition from the Tidewater Railway Co., offering to supply electricity for commercial and municipal lighting, beginning July 1st, 1912. According to the company's agreement, electricity will be furnished for lamps to private consumers on a flat rate of 10 cents per kilowatt hour, with 10 per cent discount.

BIRMINGHAM. Reports state that an application for a charter has been made by the Birmingham & Chattanooga Railway Co., to build an electric and steam railway to connect Birmingham and Chattanooga by way of Albertsville and Boaz, passing through several Alabama counties and three Tennessee counties. J. M. Spradlin of Boaz is president, and W. W. Shortride of Albertville, vice-president.

RAGLAND. It is reported that M. H. Lide of Birmingham is preparing plans and specifications for the dam and power plant on Coosa River at Lock Four for the Ragland Water Power Co.

SHADES MOUNTAIN. It is reported that an electric railway extension is being promoted by the Shades Clift Land Co., now planning to develop 600 acres on Shades Mountain, D. C. Brazleton of Birmingham, Ala., is president of the company.

TALLADEGA. The Alabama Power & Light Co. have, according to reports, acquired the necessary properties and made arrangements for the construction of a hydro-electric plant at Jackson Shoals, near Talladega. The company proposes to develop at this point about 3,000 H. P., transmitting energy to Anniston and Talladega. R. A. Mitchell of Gadsden, Ala., is president of the company.

TUSCALOOSA. It is reported that a franchise has been granted to F. G. Blair and Henry B. Foster to build and operate an electric railway and power plant in Tuscaloosa.

FLORIDA.

BROOKSVILLE. The city has granted a franchise to T. F. Fuller of Unatilla, Fla., for the construction of an electric light plant.

CHICORA. The Amalgamated Phosphate Co. plans the erection of a plant of large capacity in the near future. An electric light plant, water-works and a saw mill will be erected in connection with the plant. The manager of the company is Anton Schneider of Barstow, Fla.

FORT PIERCE. An issue of $15,000 in bonds for the construction of an electric light plant has recently been voted on.

JACKSONVILLE. The Sisal Hemp & Development Co. are in the market for a 200 H. P. generating equipment to operate a rope mill.

GEORGIA.

ATLANTA. The Appalachian Power Co. has made application to change its name to the Appalachian Electric Power Company. This company is making investigation of five properties in Northern Georgia to determine plans for development. It proposes to supply energy to Toccao, Ga., and Walhalla, Seneca and Westminster, S. C.

ATLANTA. The Central Georgia Power Company of Macon, Ga., is planning to construct transmission lines from the hydro-electric development at Jackson, Ga., to the Atlanta city limits. The arrangement at present is to sell power to the city at the substations at the city limits, the city to distribute through its own mains.

AUGUSTA. J. G. White & Co. of New York City have purchased the Georgia Carolina Power Company, including several thousand acres of land on the Savannah River at Stephens Creek. The company will build a hydro-electric plant developing 12,000 H. P. and transmit same by means of high tension lines to the surrounding territory.

BLAIRSVILLE. The Coosa Creek Power & Mining Co. has employed Arthur Pew of Atlanta to prepare plans and supply the installation of a compressed air plant for doing development work on their property near Blairsville.

CUTHBERT. Bonds have been issued and sold for the purpose of improving the municipal electric light plant and water works system. Work will begin at once.

COMER. The Comer Light & Power Company has been granted a franchise to construct and operate an electric light plant in Comer.

DUBLIN. It is understood that the Chamber of Commerce at Dublin is considering the matter of inducing the Central Georgia Power Company at Macon, Ga., to erect transmission lines to Dublin.

JACKSON. The bond issue recently reported in these columns as voted upon has been sold and the proceeds used for the purpose of changing the equipment of the steam plant to use electrical energy from the Central of Georgia Power Company's line coming into Jackson from the Ocmulgee River, near Jackson. A substation will be located at Jackson, which is nearing completion.

JESUP. The bonds recently issued have been sold and a power house will be constructed in the near future. Arthur Pew of Atlanta is engineer in charge.

JONESBORO. The city has decided to vote on the issuing of bonds for the purpose of enlarging the municipal electric light plant and water works.

MANCHESTER. The city wil receive bids during the early part of February for the construction of an electric light plant to cost approximately $65,000. J. S. Peters is city clerk.

ROME. The Chattanooga Traction Company has applied for a franchise to construct and operate an electric railroad in Rome.

TIFTON. The Tifton Ice & Power Company will increase the capacity of its electric light plant.

WASHINGTON. It is understood that the city will construct a power plant and make extensive improvements to the electric light and power transmission systems. The plans are being prepared by the Westinghouse Church Kerr & Co., of New York. Information can be secured from B. Ficklen, Jr.

KENTUCKY.

ASHLAND. The Ashland Leather Co., is in the market for a 100 K. W. generator, motors and electrical equipment.

ASHLAND. The city has decided to issue bonds for the purchase and improvement of the water-works system. Approximately $80,000 will be expended in new equipment in the pumping station and on other improvements.

CADIZ. A hydro-electric light plant will be erected near this place by Alexander Bros.

CAMPBELLSVILLE. The elctric light plant which was destroyed by fire on November 15th with a loss of $30,000, will be rebuilt and the necessary new equipment installed.

FALMOUTH. Anderson & Frankel of Lexington, Ky., have been retained for the purpose of designing electric light plant for Falmouth. The bond issue in connection with this plant was announced in the last issue of Southern Electrician.

HARLAND. The Harland Coal Company is building a power plant for the development of its property near Harland.

LOUISVILLE. According to reports surveys are being made by the H. M. Byllesby & Company of Chicago at Cumberland Falls, about 110 miles from Louisville, with a view of establishing a hydro-electric plant and supply electricity in Louisville.

LOUISVILLE. The Board of Commissioners for the new city hospital will receive bids until January 4th for the construction and equipment of the power plant. The machinery will include refrigerating apparatus, steam heating apparatus, electrical equipment and laundry machinery.

LEXINGTON. The Lexington Utilities Co. has begun the erection of a turbine station. This station will contain two 2500 K. W. horizontal turbo generators developing 4000 volts, 60 cycle, three-phase energy. A rotary converter will be installed to operate a railway system at 550 volts. The transmission line will be installed to Versailles and Frankfort 28 miles and energy transmitted at 33,000 volts. J. P. Pope is general superintendent of the lighting department and Sargent & Lundy, of Chicago, Ill., are engineers.

RUSSELLVILLE. The city has refused the proposition of W. M. Chase of Parksville, Tenn., to purchase the municipal electric light plant at $25,000.

UNIONTOWN. The Home Lighting Company will remodel the electric light plant and install two 125 H. P. boilers together with generators and other machinery. The general manager is G. W. Clements.

LOUISIANA.

LAFAYETTE. A bond issue of $50,000 is under consideration for the purpose of improving and making extensions to the municipal electric light plant and water works system.

NEW ORLEANS. The city is about to purchase a 6,000 K. W. turbo-generator and a 150 K. W. rotary converter together with switchboard apparatus. Information can be obtained from F. F. Shields, chairman of the committee.

NEW ORLEANS. It is reported that the Louisiana Southern Railroad is to be equipped for electrical operation. The road is under construction and when completed will be about 75 miles long.

NEW ORLEANS. Articles of incorporation have been filed for El Salto Power Co., with a capital stock of $300,000. The incorporators are Monty M. Lemann and Davis W. Pipes, Jr.

RAYVILLE. The city has secured W. H. Wright to prepare plans for an electric light plant.

SHREVEPORT. The Shreveport Gas Electric Light & Power Co. has decided to install a new street lighting system which will cost over $20,000. It is understood that luminous magnetite arc lamps to the extent of 285 will be installed.

MISSISSIPPI.

LAUREL. The Laurel Light & Railway Company has been incorporated with a capital stock of $500,000 by P. H. Sanders, S. M. Jones and T. W. Yates.

PRENTISS. The electric light plant owned by H. W. Hinton has been purchased by W. C. Beach. Machinery has been removed from the old power house to the Coceman Gin where it will be operated.

RICHTON. The Richton Light & Power Company will erect a new power station.

YAZOO CITY. It is reported that the Yazoo Valley Electric Railway Light & Power Company has given a contract to J. H. Collins of Chicago to make a survey for the proposed interurban railway between Yazoo City and Trenton, which may later extend to Jackson by way of Tougaloo, Richland, Madison, and Gluckstadt. H. Wise of Yazoo City is interested in the project.

KOSCIUSKO. The Planters Oil Mill & Gin Co. are in the market for a second hand alternating current generator, 75 to 100 K. W., 1,100 volts, 125 cycles, single-phase.

MISSOURI.

ST. LOUIS. Plans are being completed by the Mississippi River Power Distributing Co. for the transmission of 60,000 H. P. of electrical energy from their water power development on the Mississippi River at Keokuk, Iowa, to the United Railway Co. and Union Electric Light & PowerCo., of St. Louis. The contract to be soon awarded will include steel towers on concrete bases 800 feet apart, 75 feet high, carrying six cables. The transmission line from Keokuk to St. Louis is 167 miles and it will bgin at Hamilton, Ill., and extend to Quincy, Ill., then to Alton, Ill. The cables will be carried across the Mississippi River to the Missouri shore and across the Missouri River from North to South about six miles below St. Charles. The towers carrying the cables across the river will be 150 feet high. From this point the lines will extend to Florisant and into North St. Louis where transforming station will be rebuilt. The president of the company is James Campbell.

NORTH CAROLINA.

GREENSBORO. It is understood that the North Carolina Public Service Company plans to extend its lines to Statesville, D. C. Dale is general manager at Greensboro.

MAIDEN. It is understood that the city contemplates installing an electric light system obtaining power from the Southern Power Company.

OXFORD. The city has granted the North State Hydro-Electric Company a franchise to supply electrical energy in Oxford. The franchise requires the company to supply electricity for lighting the streets for a period of three years at the rate of $60 per arc lamp per year and incandescents at $18 each per year. The city now pays $75 per lamp per year for arc lamps and $35 per year for incandescents. The com-

pany has purchased the plant and holdings of the Oxford Water & Electric Company of which C. E. Johnson is president at Raleigh, N. C.

ROCKINGHAM. The Yadkin River Power Company has recently purchased the municipal electric light plant in Rockingham. The consideration was $15,000. By this arrangement the company secured the Blewitt Falls Plant including water rights, dams, power house and transmission lines.

SOUTH CAROLINA.

HONEA PATH. The contract for the construction of an electric light plant and water works system has been awarded to Cockran & Cockran, of Greenwood, S. C.

JOHNSTON. The Electric Light Ice & Fuel Co. has been incorporated with a capital stock of $20,000 by F. M. Boyd and D. S. Boyd.

LANCASTER. The Lancaster Light & Power Company has been incorporated with a capital stock of $5,000. The president is Leroy Springs, and the vice-president, T. Y. Williams.

SPRINGFIELD. The Springfield Valley & Wagoner Telephone Co. has been incorporated by L. M. Mims and W. D. Black. The capitalization is $10,000.

TENNESSEE.

CHATTANOOGA. The Chattanooga, Rome & Atlanta Railway Company which has recently been organized will build an electric interurban railway from Chattanooga, to Fort Oglethorpe, Rome and other cities to Atlanta. The capital stock of the company is $100,000. John H. Hill is interested in the company.

KNOXVILLE. The Aluminum Company of America has purchased power rights on the Little Tennessee River in Tennessee and North Carolina and, it is understood, will shortly proceed with the erection of several hydro-electric plants of considerable capacity. Mills for producing aluminum in Eastern Tennessee are also included in the plans.

KNOXVILLE. The Knoxville Power & Light Company has been incorporated with a capital stock of $500,000 by Asbury, Wright, R. M. Jones, E. G. Oates, Abraham Rosenthal and Walter McCoy. The company is under control of the Eastern Tennessee Power Co. and will operate under a franchise recently granted by the City of Knoxville. The Knoxville company will be served by the transmission lines from the development of the Eastern Tennessee Power Company at Parkville. It is understood that the transmission line will be completed and ready for operation January 1st.

BOOK REVIEWS.

MANUAL OF ELECTRICITY. By A. M. Schoen. Published by the Insurance Field Co., Louisville, Ky. Price, $3.10, postage paid. 348 pages, 151 illustrations.

The nature of this work is unique and unlike anything ever published intending to set forth in untechnical language the fundamental principles involved in the application of electricity and particularly in connection with the installation of equipment. All the material is original, new and up-to-date from cover to cover. The author enjoys a wide reputation as a consulting engineer and through his extensive experience with installation of electrical apparatus and through his connection as chief engineer of the Southeastern Underwriters Association, he has been able to present in this volume information vital to every electrical engineer who has to do with the installation or maintenance of electrical equipment. While the work covers a large field, in fact practically the entire field of electrical construction, the chapters on hazardous features of electrical systems, cut out, switches, meters, fittings, fixtures, etc., installation of wires, and the last chapter on instructive accidents and fires, their lessons, are distinctly valuable and the material contained in these few chapters is worth fully the price of the book. The record of data contained in the last chapter mentioned is treated in such a common sense, engineering way as to bring to the reader's attention the extreme importance of proper installation methods and material. The work will be found of daily service to every installing electrical engineer, and while not evidently written with the contractor in mind, it is suited to the needs of those who desire to satisfactorily handle electrical installations of all kinds. The book is neatly bound in red flexible leather, pocket size.

CYCLOPEDIA OF TELEPHONY AND TELEGRAPHY. Published by the American School of Correspondence, Chicago. Price $12.80.

The above work is published in four volumes, bound in half leather, printed on heavy coated paper and contains over 2,000 engravings. The work is prepared by a corps of telephone and telegraph experts and electrical engineers of the highest professional standing. In fact it presents one of the most comprehensive and authoritative treatments of the whole art of electrical transmission of its kind ever published. The sections on telephony cover the installation, maintenance and operation of all types of telephone systems. They present without prejudice the respective merits of manual and automanual exchanges, and gives special attention to prevention and handling of operating troubles. The sections on telegraph cover both commercial service and train dispatching. Practical methods of wireless construction, both by telephone and telegraph are thoroughly treated. In preparing the work, the editors acknowledge a free consultation of standard technical literature of America and Europe which has made the volume thoroughly representative of the very best and latest practice in the transmission of intelligence. We cannot recommend too highly this work on telephony and further recommend that all those interested in the field from the practical standpoint as well as a theoretical standpoint, investigate the work as a valuable addition to their library.

MODERN ELECTRICITY. By James Henry and Karel Hora, published by Laird & Lee, Chicago. Price $1.00. 150 illustrations, 352 pages.

This work is intended as a text book for student apprentices however, it is arranged in such a manner as to present considerable interesting material covering the entire field of electrical engineering, giving only the amount of theory that is absolutely required and little mathematics. The work is well illustrated and contains numerous examples carrying out the theory relative to the subjects treated.

PERSONALS.

MR. C. A. BROWN, who has had charge of the Atlanta branch office of the Standard Underground Cable Company, is to be transferred to Seattle, Washington, where he will open a new office. Mr. Brown's personality has been such that he has gathered around him in the Southern community a host of warm friends that have been loyal to him, and through their aid and assistance prosperity has followed his footsteps. His fondest hopes are that he can gather around him as warm, genial and substantial acquaintances in the far West, as has been his good fortune while in our midst.

MR. J. ALLEN WORTH has recently resigned from the Weber Electric Co. to become Sales Manager of the Push Button Switch and Specialty Department of the Cutler-Hammer Manufacturing Company of Milwaukee. Mr. Worth has been engaged in this field of the electrical industry for the past seven years. He, with Mr. Henry D. Sears, sales agent for the Weber Company, successfully marketed the first snap shell socket, at a time when the trade was skeptical of their utility. Mr. Worth's experience with the Weber Company since this time fits him for the sales management of the rapidly growing Cutler-Hammer line of switches and specialties.

MR. S. S. WARNER, who, starting on January 1st, will take charge of the Atlanta office of the Standard Underground Cable Company, for the past five years located at 1323 Candler Building, comes with the highest recommendation. Mr Warner is by no means a stranger to the South; for, in the past six years, he has very successfully traveled the States as far South as South Carolina, in which part of the country he has become very favorably known, in both a personal and commercial sense. Mr. Warner has had exceptional advantages in mastering the art of cable manufacture. The companies and engineers in this territory should certainly be congratulated that the Standard Underground Cable Company should put a man of such high standing in charge of the Atlanta office. We wish Mr. Warner the success which we know his endeavors will well merit. Mr. Warner will be assisted by Mr. J. A. Peacock at the Atlanta office.

MR. EDWARD KERSCHNER, who, for the past six years, has been traveling in the middle West for the Standard Underground Cable Company, will succeed Mr. S. S. Warner, traveling from the Philadelphia office. Mr. Kerschner's ability to give complete satisfaction to the trade is unsurpassed, he having a thorough and practical knowledge of all of the material manufactured by the Standard Underground Cable Co. Mr. Kerschner also is gifted with the art of making friends whereever he goes, and a continued prosperous career confronts him in his new territory.

INDUSTRIAL ITEMS.

THE WESTERN ELECTRIC COMPANY'S gross sales promise to total between $66,000,000 and $67,000,000 this year. Last year gross sales totaled $61,000,000 and $46,000,000 in the preceding year. In 1908 the total was $32,000,000, in 1907 $53,000,000 and 1906 holds the high record with $69,000,000. Indications of early 1911 promised a record year, but the Western Electric has shared with others an industrial slump, though not to such a marked extent. The eleven months so far reported are about three per cent ahead of the corresponding eleven months in 1910. November shows a falling off of about three per cent, as compared with November, 1910, practically the whole decrease coming from the middle West section of the country. Last month the five per cent decrease, in comparison with October, 1910, came from the eastern section, and the November returns indicate that the area of industrial depression is moving westward. The company's business farther west and on the Pacific slope is still ahead of last year's. Last year, in addition to the regular quarterly dividend of two per cent, the directors declared an extra dividend of two per cent in December, and there is every reason to believe that the company will do as well by its shareholders this year, as it is in a position to make such an extra distribution.

THE OKONITE COMPANY, 253 Broadway, New York City, has published an attractive booklet, entitled, "Economy in Joint Making, With Instructions." It contains information which should be very much in demand just at this season of the year, as now is the time to make repairs in the way of insulating and protecting joints so that short circuits, with their accompanying troubles, may be avoided during the winter to come.

Copies of the booklet can be secured on application to The Okonite Company.

THE ELECTRICAL CREDIT ASSOCIATION, of Philadelphia, held its annual meeting and banquet in celebration of the Sixteenth Anniversary, at New Hotel Bringham, Philadelphia, Novemebr 16, 1911. A large attendance and unbounded enthusiasm marked the close of a highly successful fiscal year. New York, Richmond, Va., Pittsburgh, Baltimore and Washington representatives were among the number present.

THE AMERICAN PLATINUM WORKS, of Newark, N. J., on November 1, 1911, acquired the business of the Croselmire and Ackor Co.

PASS & SEYMOUR, Syracuse, N. Y., have moved their Chicago office to 700 West Jackson Boulevard. The new quarters will give the office three times the space formerly occupied.

NATIONAL METAL MOLDING CO., through their Southern manager, L. S. Montgomery, announce a necessity to secure larger quarters for the Atlanta office. The Atlanta office is now located at 501 Fourth National Bank Building, Atlanta.

THE LENSED ELECTRIC SHADE CO., of 101 Warren Street, N. Y., has recently made an announcement that early in January an exclusive line of translcent glass reflectors will be marketed for use with Mazda lamps. The reflectors will be known as Nubolux and manufactured under license of Holophane Glass Company.

Alphabetical Index to Advertisers.

SOUTHERN ELECTRICIAN

PUBLISHED MONTHLY

Vol. 44. FEBRUARY, 1912 No. 2

ADDRESS COMMUNICATIONS TO

SOUTHERN ELECTRICIAN

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H. H. KELLEY
F. C. MYERS
L. L. ARNOLD } Associate Editors.

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Industrial Power Service.

Uncertain and irregular power demands have been one of the great handicaps to the development of small and medium sized central stations since the beginning of the industry. The advantageous features of the long-time load on generating and distribution apparatus are generally recognized yet recent activity has been toward cultivating the off-peak demand. From the station management standpoint, the regular off-peak load is most desirable and on this account made favorable also to the industrial establishment through reasonable and attractive power rates. With careful study and manipulation of these demands, an approach is possible to the ideal load curve representing the maximum output for the plant without a decrease in efficiency of production. Such an ideal load curve would be a straight horizontal line. This in practice is beyond hope, however, the approach is found through the proper solicitation of such loads as charging of storage batteries for day use, operation of printing plants issuing morning papers, and furnishing electric energy to the electric furnace and to bakeries. These loads properly connected with long-hour loads, such as city pumping, refrigeration, etc., build up a power demand which does not interfere with the peak lighting demand and deprive the station of possible profitable business from the overlapping of the hours of maximum but limited volume of the twenty-four hour output.

At the present time, the general slogan of the country is economy and central stations are generally making these improvements to their load factors, devising better arrangements of apparatus and purchasing more efficient apparatus. Further, the revising of rates, offering customers a decided saving as compared with the industrial power plant proposition, is an important factor. Systems of cost are far more complete and accurate today than they ever have been, affording a detailed analysis from which betterment can be made. From these accounts the relative value of the various items in making up the cost can be obtained. In almost every industry the question of power cost is a most important item, and must receive careful analysis from the standpoint of economy. The position which electrical energy holds in questions of power economy is well established for it has become the logical means of applying power originating at water wheels, steam or gas engines. With the demand for power thus established, the station management have now before them the problem of selling it to the advantage of user and themselves. In this regard graphical records are particularly useful for obtaining power requirements and analyzing industrial demands, since records of the exact conditions for a definite period are presented showing up demands for all phases of any particular load. The proper adapting of the demands therefore during a twenty-four hour period, whether by the long time or off-pead load, enable the calculation of the value of the service to the station and give a definiteness to the rate which can be offered.

There is a marked tendency toward the replacement of existing power stations having units of small capacity

with centralized power plants containing large units. This development is by no means local, the increased demands for electrical energy are compelling stations all over the country to take steps toward larger capacity. This tetndency toward the installation of large units noted in power station construction also extends to sub-stations. In general, the present generating and distribution systems are being built up on the anticipation of a future demand on such systems as large if not larger in proportion than in the past. While the power service of any station is now a problem of large propositions, as conditions stand there is little hope for it being narrowed down to absolute definiteness for some time. The increasing activity in the central station field and the tendencies of centralization, however, should mean improved load factors, better efficiency, more reliable service and a lower rate.

Is 1912 Business to be Better or Worse Than 1911?

The scare connected with the business outlook for a presidential year is now on. That this is a presidential year and that business is always more or less disturbed during a presidential campaign, are the premises for the final deduction that for all kinds of trade, the next twelve months must be expected an off year. The central station generally the least affected, has not yet begun to air its particular phases of depression, however the contractor and electrical manufacturer are going through the preliminaries necessary to later effectively respond to the question, "How's business?" with a long face and a suggestive shake of the head.

The causes for this general feeling of an inevitable trade depression suggest an interesting psychological study. Every psychologist tells us that with a little earnest effort we can convince ourselves that we are hot or cold, sick or well, etc., and while there are a few of us who perhaps think we are too strong minded to be subject to such mental derangement, we have in our own person a subject for introspective study. After John Jones a party leader and perhaps a prominent and experienced business man, has aired his honest opinion to a few of his friends that business during 1912 is going to be generally bad, and each of those friends have in turn spread the news, each and all pessimistically inclined will be in a mood for discussing bad trade conditions and contented to withdraw extra efforts to secure new business from fear that the expense entailed will not be justified. All this seems logical enough and past years seem to substantiate the conclusion they reach.

Let us, however, look at the situation from another angle. We will grant that past presidential years have been attended by a feeling of general business unrest, we have heard all about the tariff, the trusts, and we have observed the working of one party against another trying to outdo the other in the matter of destroying everything that is big or progressive, but after all is said and done, have we not each and all gone back to work and business gone on at the same old stand in much the same old way as before? When we stop to consider the apprehension and forebodings and general misgivings as to the outcome that has attended all previous campaigns, does it not seem most absurd and particularly foolish for a Nation that claims to be progressive, conservative, free thinking and boasts of being in advance of others, to let its imagination get the better of its common sense? If every business man in this country were to resolve to absolutely ignore politics and politicians in connection with his business during the rest of the year and keep his club ready at all times for the fellow who wants to talk politics when he ought to talk business, then there need be no further worry about the presidential outcome and the effects of the opinions of trade depressionists. Loyalty, enthusiasm and confidence in a well directed organization for the future, whatever be the business, are justified by records of past years and these three essentials are strong enough to absolutely destroy any shadows that the political world has a tendency to see during every presidential campaign. It has been said, and justly, that what our country needs is more business men and statesmen and fewer political bosses.

It may be interesting to review in a general way the condition of business in the Southern electrical field, at the close of 1911 and the beginning of 1912. According to reports of the various companies doing considerable business among contractors and central stations, and from reports from certain sections covering the business done, it is learned that during the last of November and throughout December nearly all buying was for immediate use without particular plans for the future demand. However, orders were being apparently closed with disregard for the usual tendency to wait until the first of the New Year. In most cases the machinery manufacturers reported entirely favorable business and considered the general tone of trade, while quiet, to be satisfactory, and the outlook for buiness during the first of the year, after inventory season, to be as good as during the past few months.

Reports now coming in for the first of the year consider the business in sight to be of fair proportions and that the trade in Southern territory at large is holding up as well as predicted earlier. Manufacturers and dealers have noticed no large increase in number of inquiries and orders, however, they have been kept busy with the usual run of orders already at hand. The outlook for the immediate future is reported excellent in practically all lines. The favorable feature of interest in the South is the marked activity in construction work requiring a large amount of equipment both in machinery and power apparatus.

The first general opinion of interest as showing the expected effect of the presidential year upon a business covering large territories, is the information presented in a recent issue of the *Railway Age Gazette* and giving expressions from a number of presidents and other executives of railroads. The opinion is general that business will not fall behind 1911, however, no enthusiastic expressions are given concerning the prospects. The presidential year is particularly referred to and one railroad president states that the incentive for capital to go into new 1912 railroad enterprises is lacking, without offering a reason. From all indications it is plainly evident that the general depression movement has not struck the South to a noticeable extent. It will therefore be seen that with a sufficiently supported determination, it is altogether possible to hold up our business by meeting the conditions squarely and putting the necessary energy and enthusiasm into our new business campaigns, making 1912 as much of a record breaker in quantity of business in the South as previous years have been.

American Switch Gear Structures and Distant Control Apparatus.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY STEPHEN Q. HAYES.

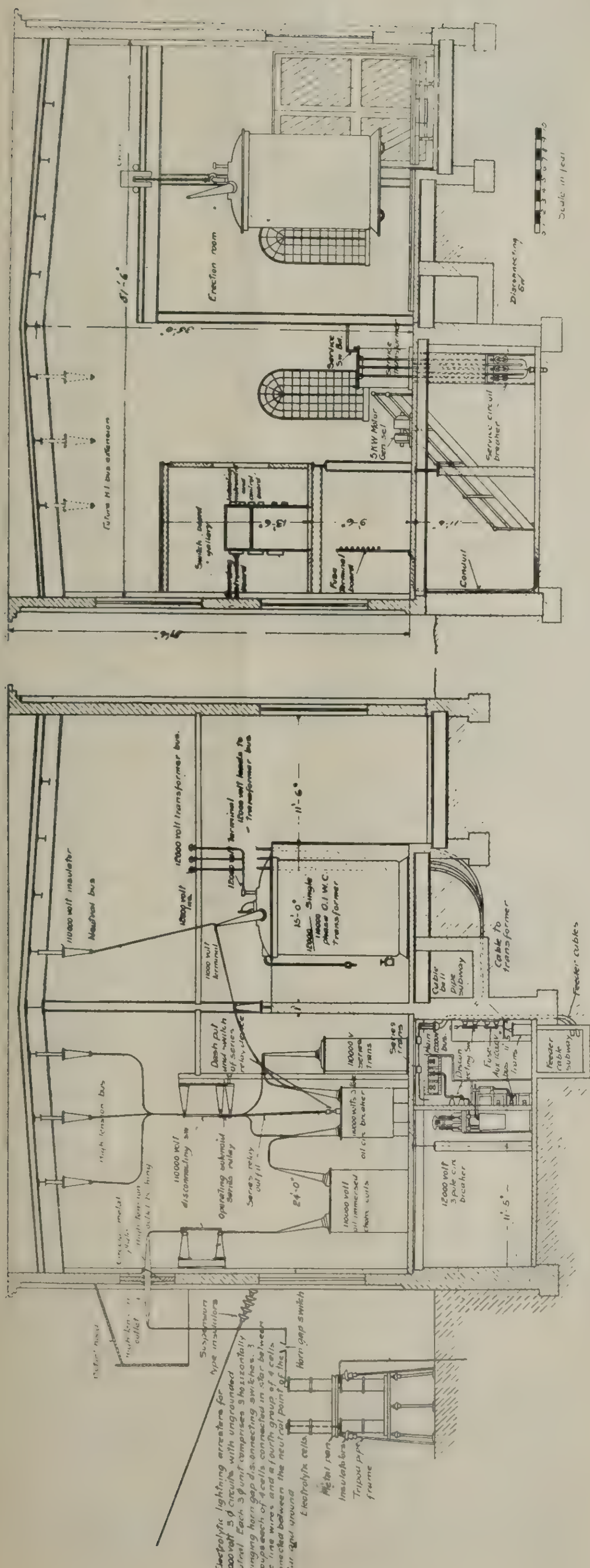

FIG. 18. SECTIONS OF 110,000 VOLT ONTARIO STATION.

IN the articles published in the July, September and December issues of SOUTHERN ELECTRICIAN, the writer discussed the requirements and general features of American plants using switch-gear structures on systems from 2,200 volts up to 100,000 volts. In this article designs of plants and switch-gear apparatus for 100,000 and 120,000 volt operation will be considered. This will complete the discussion of typical structures, in the following articles some of the important details such as bus-bars, wiring, insulators, supports, brackets, etc., will be considered in connection with distant control switch gear.

In Figs. 18 and 19 are shown the preliminary views of the 110,000 volt step-up transformer station that is installed at Niagara Falls for delivering power to the Hydro-Electric Power Commission of Ontario. This station receiving current at 12,000 volts from the Ontario Power Company's plant is provided with three banks of step-up transformers, each bank comprising three 3,000 Kva units stepping the voltage up from 12,000 volts delta to 110,000 volts star. It is the intention that the station should later be extended to take care of an ultimate installation of eight banks of transformers. Fig. 19 shows the elevation of this station, while Fig. 18 shows two sectional views through the station where it may be noted that the open system of wiring is used throughout for the 110,000 volt circuits.

The instruments and control switchboards will be located on a gallery at what will be the ultimate center of the building. The 12,000 volt circuit breakers with their busbars will be located in the basement, while the step-up transformers and the 11,000 volt switching equipment will all be located on the main floor. Arrangements are so made that any transformer may be run out on a track and then pulled to the center of the building where a crane is available for lifting the transformer and for other assembling purposes. Since the contract for this equipment has been received, various minor modifications have been made in the design of the lightning arresters, switch gear, etc., so that the actual installation differs in some respects from the arrangement shown in these cuts. Although the step-up transformers are connected in star on the high tension side, it is the intention to operate the system without grounding the neutral so that all of the apparatus, switch gear, etc., has been designed with that end in view and is arranged to stand insulation tests suitable for such a method of operation.

While no views are given here for the layout and general appearance of the building for a proposed terminal station, the details will suffice to show the design to take care of an ultimate total of six 120,000 volt, three-phase incoming transmission lines, each capable of carrying 20,000 K. W., 25 cycles, twelve 10,000 Kva., 120,000-12,000 volt three-phase step-down transformers and a large number of 12,000 volts, three-phase distribution circuits. The 120,000 volt

circuits in this plant are obtained from star connected transformers, whose neutral point is to be solidly grounded, thus greatly reducing the insulation strain on the various portions of apparatus, and actually permitting the use of slightly smaller switching apparatus than was required for the 110,000 volt installation shown in the previous cuts.

The 120,000 volt circuits are to be brought in through condenser type bushings located in the roof of the building, and the 120,000 volt lightning arresters are to be installed also on the roof of the building. From the inlet bushing the current passes through disconnecting switches to the high tension bus, which bus is arranged to switches to the 120,000 volt oil circuit breakers and series transformers and thence through other disconnecting form a continuous ring.

The connections are so made that under normal conditions each 20,000 Kva incoming line will supply current to two 10,000 Kva stepdown transformers. The 12,000 volt circuits from the stepdown transformers pass through a circuit breaker to a transformer bus. This transformer bus in turn connects through a second breaker to the main low tension bus, or through either of two other breakers to two group buses, each group bus being used for supplying current to four 2500 Kva feeder circuits. With this combination ring and group system on the low tension side and the ring and group system on the high tension side a great amount of flexibility is secured with a comparatively small amount of switching apparatus. A plan view of this same station indicates clearly the large amount of space required for the switching equipment and the busbars in the 120,000 volt circuits. The 12,000 volt circuits are arranged in galleries along one side of the building and the operating room forms the central portion of the building on the gallery side.

In the operating gallery of this section the general arrangement includes a control desk placed on the upper gallery, this desk being equipped with vertical edgewise instruments and being built in six sections, each section controlling one incoming line, two 10,000 Kva step-down transformers and eight 12,000 volt feeders. This desk contains merely the indicating instruments and control devices that the station attendant requires for the proper operation of the plant. On the floor below are located the various intergrating watt-hour meters, graphic recording meters and similar instruments required for the records of the output of a station of this capacity. This second gallery also contains a local service switchboard and the equipment of local service transformers, storage battery, charging generators, etc. On the next lower floor are placed terminal boards containing the relays for the various circuits and enclosed fuses in all of the secondary circuits from the series and shunt transformers to the instruments, as well as fuses in the circuits to the various breakers from their controllers. The main low tension transformer breakers with their tie and group breakers are located on the upper gallery, while the main and group buses are located on the intermediate gallery, and the feeder breakers on the bottom gallery. The basement contains the buses that are required for closing in the ends of the ring system. The conduits for the various control and instrument leads are shown running from the desk to the instrument board and the terminal board and from these parts of the station they are run to the breakers located in the various parts of the

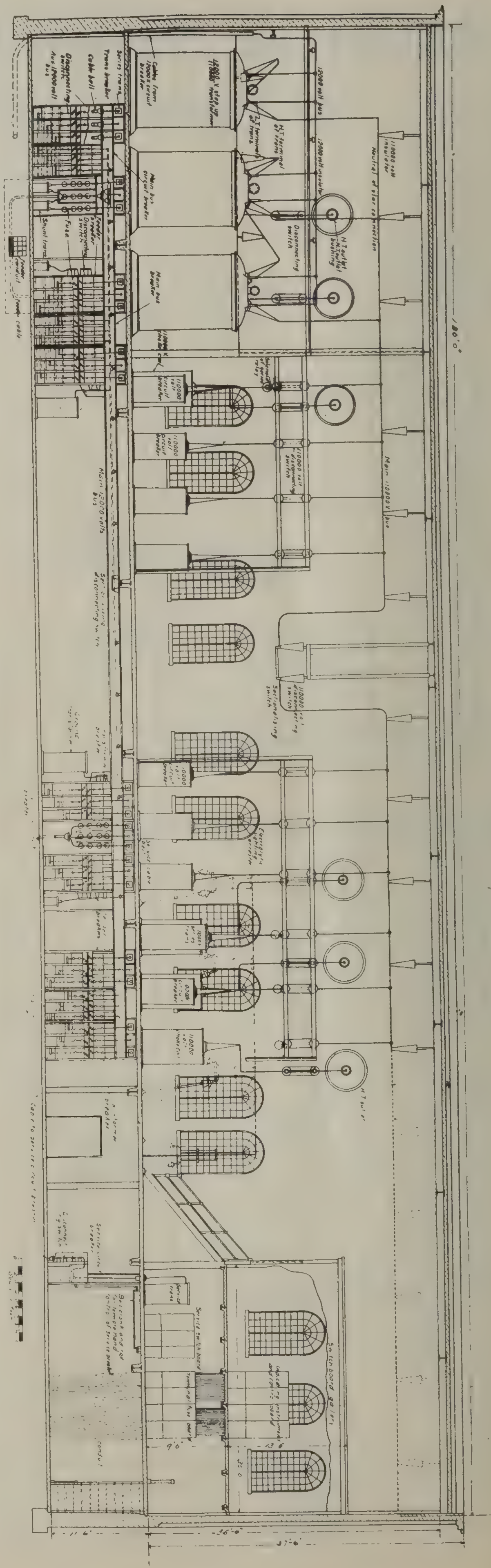

FIG. 19. ELEVATION OF 110,000 VOLT ONTARIO STATION.

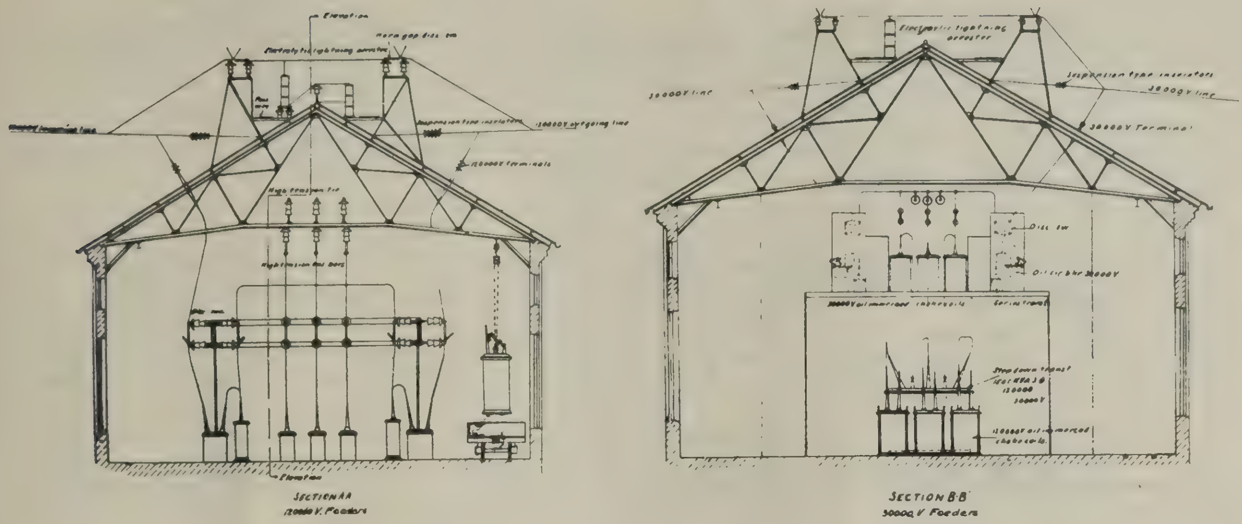

Fig. 20. Sections of 120,000 Volt Breaker Station.

building. As a matter of interest it might be noted that approximately four miles of iron pipe conduit would be required for the installation of the instruments and control leads. It is quite probable that some of the details in the design of this station will be modified when the station is installed.

In connection with the transmission lines running to this station it may be noted that the intention is to have a total of six lines arranged in three sets of two each on steel towers each pair of lines following a slightly different route between the generating station and the receiving station so as to avoid, as far as possible, having all of the transmission lines subject to the same trouble from floods, storms, etc. It is also the intention to install at various points 30 or 40 miles apart along these transmission lines, auxiliary switching stations with knife type disconnecting switches located on towers and arranged to be operated from a platform. These knife switches connected in the main lines will never be used to open the circuit under load, but will simply be employed to divide the line up into sections for the purpose of inspection and repairs.

In addition to these tower stations with knife switches that will be furnished for each pair of lines at several points along the route, all these sets of lines will be brought together and run through main switching stations 60 or 70 miles apart where oil circuit breakers will be installed that can be used to open up any circuit under load and to automatically cut out a damaged line. Owing to the extremely high protential of the transmission lines ,and the impossibility of building economically transformers of small output suitable for connecting directly to the line, it is the intention to install in the circuit breaker station, transformers of approximately 1500 Kva capacity stepping the line voltage of 120,000 volts down to a voltage of approximately 30,000 volts, and power will be distributed locally at 30,000 volts from the circuit breaker station. In addition a 30,000 volt transmission line will be run along one of the main sets of towers, this transmission being fed from the various circuit breaker stations in such a manner that no point of the line will be more than approximately 30 miles from a station feeding into this 30,000 volt line.

In Figs. 20 and 21 are shown sections and elevation of one of these circuit breaker stations containing the step-down transformer that supplies the current to the 30,000 volt line. This station contains the necessary switching equipment for six incoming lines and six outgoing lines of 120,000 volts, 20,000 K. W. capacity each. Each incoming line and each outgoing line is provided with a breaker and other breakers are furnished for connecting to the high tension bus. The 1500 Kw transformer with the circuit breakers for the 30,000 volt line are also installed in this station.

One point of particular interest in connection with this plant is the arrangement of the lighting arresters on the roof and the use of two sets of horngaps with one set of electrolytic tanks for each incoming and outgoing line in order to reduce to a minimum the number of electrolytic cells required. The 120,000 volt line passes through the roof of the building by means of condenser type bushing mounted in the roof. This station is arranged with two railway tracks passing through it and a small hand crane running on a single rail for the purpose of unloading the cars and handling the apparatus.

Fig. 22 shows the arrangement of one of the tower switching stations, this tower switching station being used

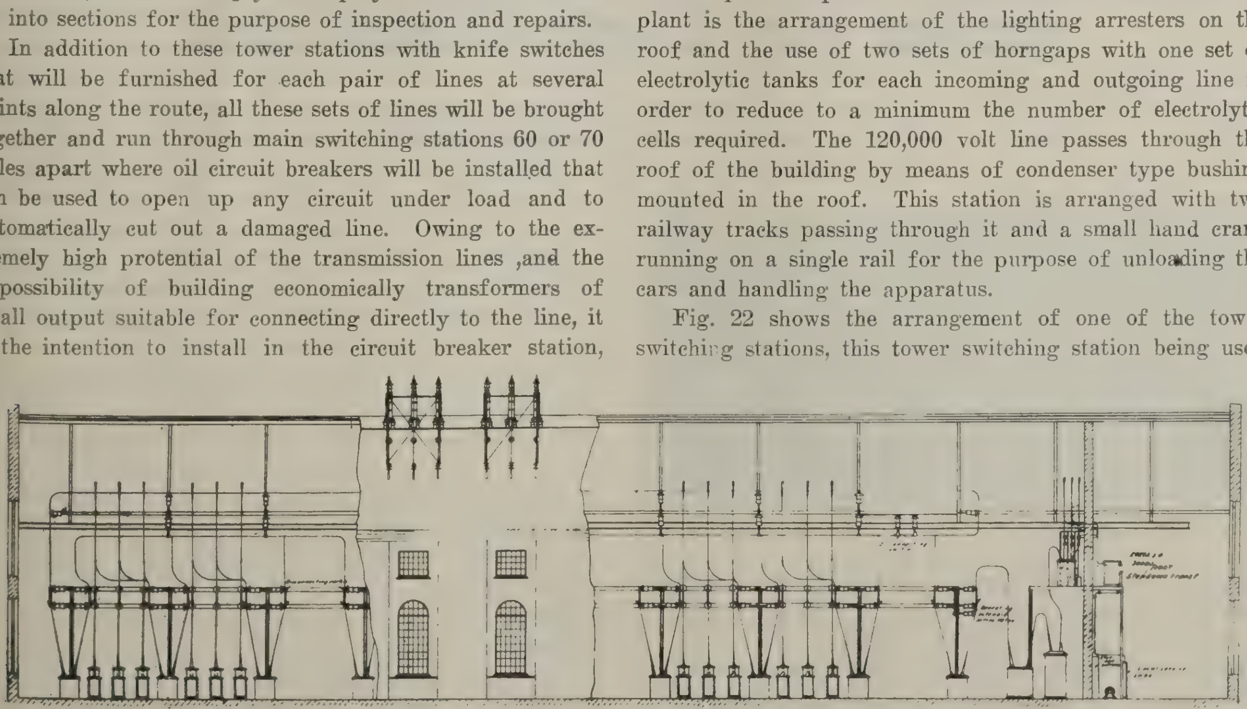

Fig. 21. Elevation of 120,000 Volt Breaker Station.

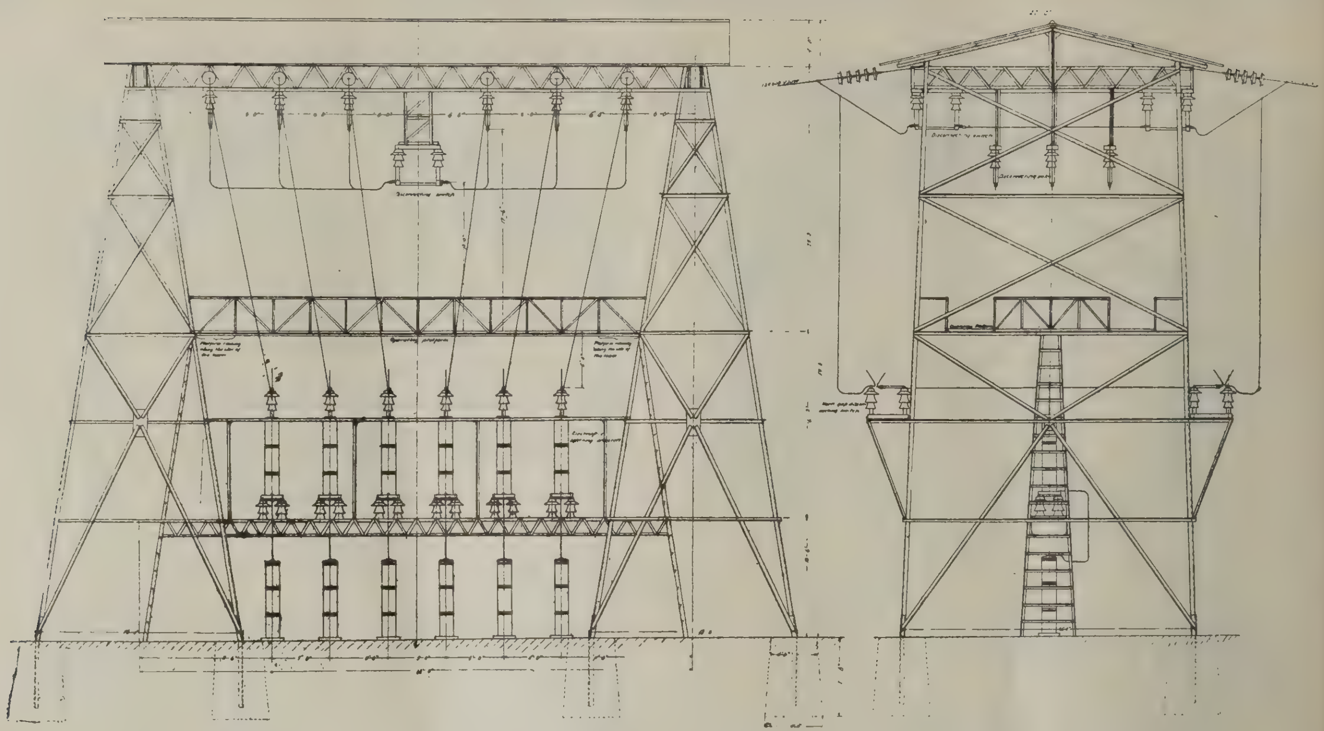

FIG. 22. ELEVATIONS OF 120,000 VOLT SWITCHING STATION.

for sectionalizing two of the 120,000 volt lines. On this tower are to be placed a total of 15 single pole single throw disconnecting switches arranged in groups of three each for each of the two incoming lines, the two outgoing lines, and a cross connection between these lines. In addition to these disconnecting switches, two sets of three-phase electrolytic lightning arresters are furnished with a total of four sets of horn gaps, so arranged that each set of tanks has two sets of horn gaps in order to minimize the number of tanks required. When this plant is finally installed it is quite probable that various minor changes will be made from the arrangement shown in the previous cuts.

There are, of course, a great many other interesting points in connection with the designs of alternating current stations with distinct control switchgear that cannot be touched on in an article of moderate length, but it is hoped that this series of articles will give a fairly comprehensive idea of the present state of the art with respect to the arrangement of the structures for distant control switch gear.

Instument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY E. P. PECK, ASST. ELECTRICAL ENGINEER,
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A Discussion of Laboratory Instruments, Control Devices, and Sources of Supply for Medium and Small Station Use. Subject Continued from December Issue.

SECONDARY AND TRANSFER STANDARDS.

The potentiometer is a fairly rapid instrument to use, but it should be reserved for work requiring accuracy, such as checking the working instruments, and not be used for general work. As the potentiometer is strictly a direct current instrument, some secondary standards are necessary which may be checked against the direct current standards and used on alternating current for checking the alternating current instruments. These secondary standards should be so constructed that they are accurate on both direct and alternating current, and should preferably be astatic, or free from errors due to stray fields. As this line of apparatus is between the primary standards and the portable test meters, it will be laid out with the sole idea of being used to check the line of test meters which will be taken up later. In this section of the equipment as in all others, it will be noted that the least number of parts necessary to cover the work is recommended.

A direct current laboratory voltmeter is advisable as it will relieve the potentiometer of all ordinary voltmeter checks, and may be used in conjunction with the potentiometer for checking the laboratory wattmeter. The range of the meter should be such as to cover the regular voltages on the system. One having 150 and 300 volts for the full scale values is often the most convenient, though other ranges should be added if needed. For instance, some companies need a 3 volt scale for storage battery work, and some a 600 or 750 volt scale for trolley voltages.

An alternating current and direct current laboratory standard wattmeter is recommended. It is most convenient

for checking wattmeters; in fact, it is almost essential, as many portable wattmeters are not correct on direct current unless the average of two readings, taken before and after reversing the current and voltage, is used. Some wattmeters may not be used on direct current at all. This instrument should be astatic, for much more accurate and rapid work may be done with it if it is astatic. The voltage ranges of the instrument should be such as to give best results on the system voltages, keeping in mind that all high voltage work is done through instrument transformers. Meters having 150 and 300 volts as the maximum values are usually the most convenient. Various current ranges may be considered advisable, and if this meter is to be used for other work than checking the secondary standards, a wide range of current values is advisable. For this particular purpose, however, a 5 ampere current coil is all that is needed. An alternating and direct current laboratory voltmeter may be convenient, but it may be dispensed with, as all alternating current voltmeters may be checked against the direct current laboratory voltmeter.

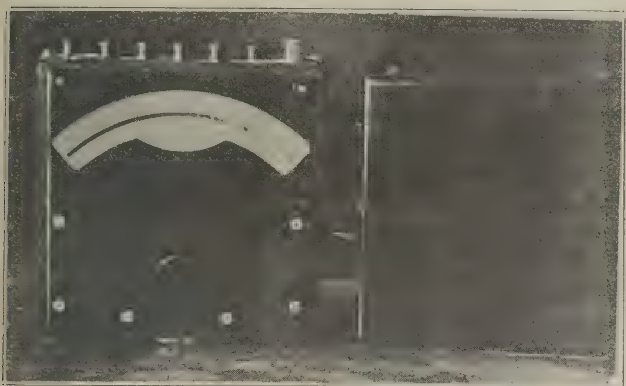

Fig 4. Hickok Astatic, Even Scale, Laboratory Standard Watt-Meter for 150, 300, 450, 600, 750 Volts and five Amperes.

One of the most essential instruments in the laboratory is a meter for measuring amperes, which is correct on both alternating and direct current. Most of the prominent makes of alternating current ammeters, both for switchboard and portable use, must be checked on alternating current, as they are very inaccurate on direct current. Several forms of electrodynamometers and ampere balances are available for this work. One company is making an elaborate outfit of apparatus, on a modified hot wire principle, which covers a large range of voltage and current values. This instrument, used in connection with a potentiometer, balances the alternating current values against the direct current values and is capable of very accurate results. The cost of a complete outfit is high however, and several observers are necessary for its use. There is promise of at least one indicating ammeter which is astatic and is correct on both alternating and direct current, but this meter is not on the market as yet.

This current measuring transfer standard need have a range up to 5 amperes only, if it is to be used only to check the portable instruments. The writer has obtained very satisfactory results from a small 5 ampere current balance made in his laboratory.

All of the transfer standards should be dead beat, as a steady alternating current supply is very rare, and a pointer which is continually swinging over the scale will make any degree of accuracy impossible.

Very few indicating instruments are accurate over the whole range of the scale. If the test shows any error greater than the allowable error, which is generally taken as 1/5 of a small division on a portable meter, a curve showing the meter error should be made and fastened in the meter cover. In the curve shown in the December article the horizontal line of the figures give the scale readings, and the vertical line of figures give the amperes to be added or subtracted from the reading to obtain the true value. A convenient scale for the vertical line is to make two divisions on the curve represent an error of one division on the meter. A scale magnifying the errors more than this causes the observation errors to show up excessively, and no greater accuracy is obtained.

LABORATORY SOURCES OF ELECTRICAL SUPPLY.

The laboratory should be connected with the regular system for its source of energy and to obtain current for many tests. The potentiometer requires almost absolutely steady current, however, and should be supplied from storage batteries which have no load except the instruments being tested. A set of small storage batteries, with some method of charging them, is essential for the exact measurments which require a small direct voltage. A few cells, say twelve, of large capacity are necessary for the heavy direct current testing. These cells should be so connected that they may be used in series, multiple, or groups of different series multiple combinations. The size of these cells and the methods of charging them will depend on the requirements for the current and on the available current supply. In one laboratory the heavy current cells are charged by being cut in series with a large motor driving an exhaust fan.

The alternating current supply may be taken direct from the company's mains if the voltage and frequency are reasonably steady. If such a source is not available and if alternating current is necessary, it will be advisable to install a motor-generator set in the laboratory. The motor, with speed control, should be supplied from a storage battery or other source of steady current. The generator should be designed for the voltage and frequency desired.

For the heavy alternating current supply a 3 kilowatt or 5 kilowatt low voltage transformer is very useful. This may be made by removing the high voltage winding from an old stock transformer and replacing it with a winding of large wire which will give 12 volts and 24 volts secondary.

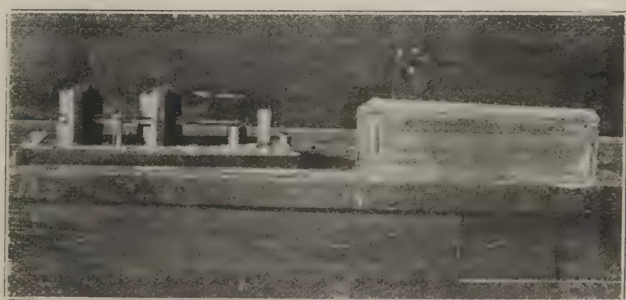

Fig. 5. Ampere Balance, 5 Amperes.

The regular secondary is not disturbed and now becomes the primary, and with the two new secondary windings, arranged for series and parallel connections, the transformer is a most convenient source of heavy alternating current supply. As the transformer and heavy direct current supply are of about the same voltage, the current regu-

lating rheostats may be used with either supply if desired. Of course, if the amount of work handled is sufficient to keep both alternating and direct current apparatus busy a large part of the time, separate rheostats will be necessary for each and can be wired in permanently.

Stray magnetic fields are a source of frequent and troublesome errors, and for this reason the heavy current apparatus and wiring should be located as far as possible from the other test apparatus, and the two leads of each circuit should be run together. Where temporary connections are made to test instruments it is well to twist the leads together, and under no circumstances should the leads form a loop around any instrument.

RHEOSTATS AND CONTROL.

The writer has done considerable experimenting in order to design a rheostat which will have a suitable range of current values, not be subject to loose connections or variable contact resistances, and not subject to changes in resistance due to heating. A water rheostat is convenient and very satisfactory for very heavy work, but has no place in a laboratory for exact work. Its temperature coefficient is very high and it is necessarily "sloppy." Carbon rheostats, made of a stack of arc light carbons broken to about 4-inch lengths, have been tried and found satisfac-

FIG. 6. PRACTICAL AND USEFUL RHEOSTATS.

tory for quick work which does not require extremely steady current. They are convenient to have in the laboratory, and are easy to make. The rheostats shown in Fig. 6 were made for 6 volts and 75 amperes. Several of these with series and parallel connections will give a wide range of current values. The inside dimensions of the box holding the carbons for the rheostat mentioned above is about 3½ inches long by 5¼ inches wide. A rheostat made as described should be about 18 inches long for use on 24 volts. The sides and back should be fixed and the front movable. The resistance is easily and quickly varied by the hand wheel on the front. Connections to the rheostat are made through copper plates fastened to the front and back. Trouble may be experienced in a long rheostat, due to the carbons getting out of place. This may easily be overcome by placing sheets of ⅛-inch copper, across the box, between the carbons about every 4 inches.

The most satisfactory rheostat has been found to be one made of wire, for the small currents, and metal ribbons for the larger currents. The metal should have a temperature coefficient, which is practically zero. The wire rheostats shown were made of Advance resistance wire. In Fig. 6 two rheostats are shown which were made to work in parallel and together give current values from .2 ampere to 75 amperes, on from 2 to 8 volts. Ribbon resistances arranged to parallel with these carry up to 225 amperes.

The small rheostat is made of a spiral of wire, laid in a circular groove in the face of the board and fixed in place with plaster of paris. A laminated copper contact is pivoted in the centre of the coil and makes a very reliable contact in all parts of its range. If the groove is made deep enough, so that only the top of the coil is above the wood, very little trouble is experienced with the wire getting loose. One rheostat of this design has been in use by the writer for about a year, and gave such good service that several more have been made. The contact spiral has a resistance of approximately 7 ohms and is in series with a coil, in the space below, of approximately 5 ohms. Thus, on 2 volts the slide will give as low as .17 amperes, and with 6 volts will give from .5 amperes to 1.2 amperes, and in steps to small to show on the instruments. The small switches at the sides of the wire are to cut resistance coils in parallel with the slide wire. One of these resistances is adjusted so that it takes slightly less current than the maximum obtainable on the slide wire, and the other one takes slightly less than the slide wire and the first coil in parallel. By this arrangement the rheostat has a range of from .5 am-

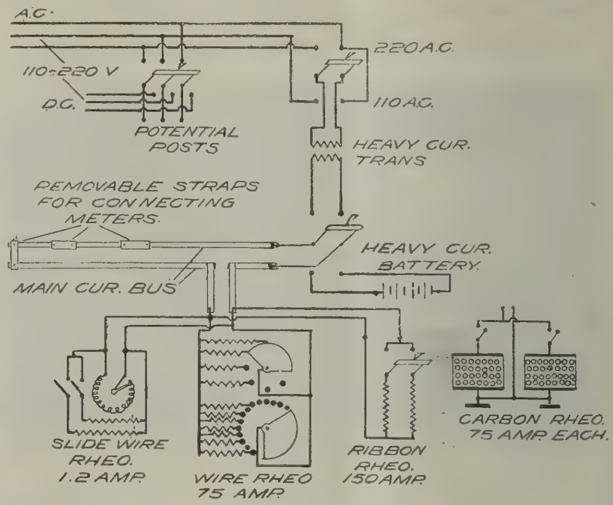

DIAGRAM FOR WIRING OF BENCHES FOR HEAVY CURRENT CHECKS, WITH POTENTIAL POSTS FOR WATTMETER CHECKS.

peres to 4 amperes on 6 volts and the current graduations are extremely small.

The larger rheostat has two sets of coils connected to two dials. The smaller coils, of which there are five, carry about 3 amperes each, and the larger ones carry about 10 amperes each. The dial switches are arranged to connect the coils of each group in parallel. It will be seen that these two rheostats are made so as to cover all current

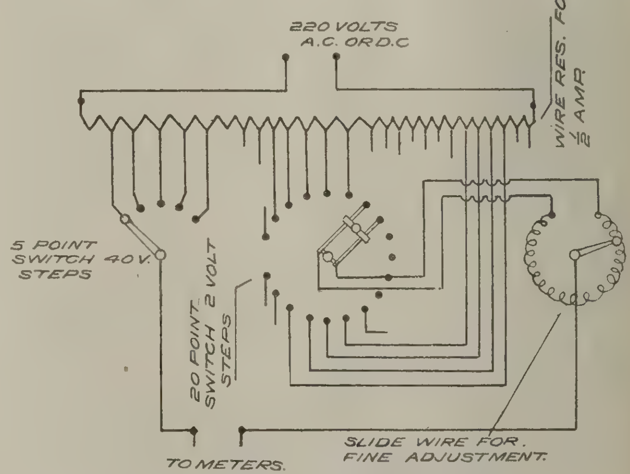

DIAGRAM OF VOLTAGE REGULATING RHEOSTATS.

values up to 75 amperes conveniently and smoothly. The two ribbon resistances mentioned above are connected to knife switches and extend the range to 225 amperes. For current above this range the carbon rheostats are also cut in parallel and currents up to 500 amperes obtained. As this value is the maximum which the standard resistance in the laboratory will carry, provision is not made for higher current values. If very high currents are required, a wire rheostat submerged in running water is very convenient, as the wire will carry about ten times as much current in running water as in the air. For some tests a lamp bank may be necessary. This should be wired so that some of the lamps may be thrown in series for small variations of the current.

The circuits in the laboratory should be arranged so that the rheostats and instruments may be connected with a minimum of time and temporary connections. All often repeated tests should be provided for as far as possible in the permanent wiring. The insulation of all circuits should be good, for an almost inconceivably small current leak will give errors when using the potentiometer. Many laboratories have had to take extra precautions in the insulation of the precision wiring and instruments. The potentiometer bench in Fig. 3 of the December issue, shows the instrument on a large plate glass which is supported by porcelain knobs. The galvanometer is also on glass and all connecting wires are run so that they touch nothing but the binding posts.

The complete layout given above would be suitable for a central station having 5,000 to 10,000 meters and the same line primary standards with some additions should be sufficient for still larger companies. A second potentiometer may be necessary, and an increased number of secondary standards will be needed to handle the work rapidly in the very large company. The smaller companies would not be justified in spending the amount necessary to purchase such a complete outfit.

The cost of the secondary standards may be as much or more than the cost of the primary standards. The secondary standards are necessary when a large amount of work must be done rapidly and accurately, but they have not the permanency and range of measurements that the primary standards have. Therefore, for a company which could not afford all of the apparatus, but which needs the foundation of a laboratory, the potentiometer, with its accessories, would be recommended. All portable direct current voltmeters and ammeters could be checked against it and their accuracy be maintained.

The smallest companies will of course require no laboratory, as the income will not justify it. Even the very small company, however, should have some reliable portable instruments for its own and its customers' tests. These will be taken up in a later article.

The following is a summary of laboratory instruments required by the average central station: Potentiometer; galvanometer; two Weston standard cells; volt box with .1, .01, .001 taps; one-tenth ohm standard resistance; one-thousandth ohm standard resistance; laboratory voltmeter for direct current with 150 and 300 volt scales; laboratory voltmeter for alternating current with 150 and 300 volt scales; laboratory wattmeter, 5 amperes and 150 and 300 volts; an alternating and direct current transfer standard; Wheatstone bridge.

A CORRECTION. On page 228 of the December issue, fifth line from the bottom of the second column, the text reads as follows: "The tables or benches for testing should be made of heavy metals and very solidly braced." The word "metals" should be material. Wood, marble or slate are satisfactory materials, but metals, particularly iron, in large masses should be kept as far from the testing benches as possible. In the diagram of potentiometer circuits on page 229, the galvanometer series resistance is shown connected to an open switch. This resistance should be permanently connected in series with the galvanometer and the switch connected so as to short circuit the resistance after the preliminary adjustments of the potentiometer are made. It is to be further noted that the meter calibration curve on page 228, is shown plotted on section paper having two divisions for an error of five meter divisions. The paper actually used for these curves was ruled ten to the inch and an error of five meter divisions is plotted so as to cover ten divisions on the curve. In other words the meter error in divisions is multiplied by two for plotting. As this is mentioned in the text, the curve as shown may be misleading...Ed.

Calculation of Voltage Drops in Unbalanced Three-Phase Circuits.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY HARRY P. WOOD, PROF. ELECTRICAL ENGINEERING, GEORGIA SCHOOL OF TECHNOLOGY.

IN designing the feeders to the load centers of a three-phase transmission system, the following problem may arise: Given the three line currents, the resistance and reactance of each of the line wires and the three delta voltages at the generating station, what are the voltages at the center of distribution? Such an arrangement of circuits is shown by Figure 1. Whatever difficulty is experienced in solving the above problem, arises from the fact that we have no apparent starting point. The usual statement for a similar problem is based upon the assumption of balanced voltages at the loads and the voltages required at the generating station calculated.

It is assumed that the currents in each of the three line wires are known or that they may be measured by the switchboard or portable instruments. In practice, these currents may have any value provided that the sum of the two smaller ones is equal to or greater than the third. Values of 100, 60 and 30 amperes in the respective line wires is an impossible condition for 60 plus 30 is less than 100. Extremities of the vectors of the three currents drawn to scale and in the proper phase relation must have the positive abscissae equal to the negative abscissae and the positive ordinates equal to the negative ordinates. In other words, the sum of the currents flowing away from the generator at any instant equals the sum of the currents flowing toward it. The three current values will form a triangle, and by combining them graphically in a triangle we have

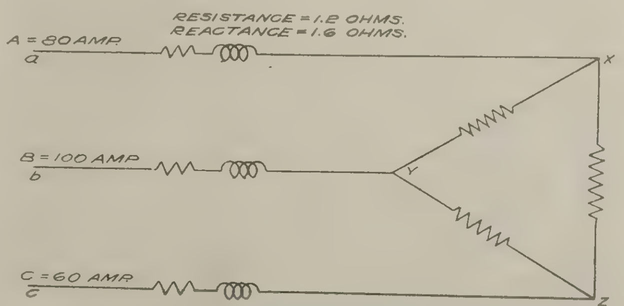

FIG. 1. DIAGRAM FOR DELTA CONNECTED THREE-PHASE TRANSMISSION SYSTEM.

determined their relative phase positions. Their phase with reference to the voltages is however not yet determined.

The ohmic resistance of each line wire can of course be found when we know the length and gauge. It is well to remember the fact that a change in the temperature of the surrounding air of 45 degrees Fahrenheit will cause a change in resistance of ten per cent. The extreme range in temperature from summer to winter therefore may cause a change in resistance of as much as twenty per cent. The proper calculation of the reactances of each of the line wires, assuming that they are supported on the same cross-arm a certain distance apart, with or without transposition, is a problem in itself and will not be taken up here. Tables giving the reactances at different frequencies and spacings are published and fair values can be derived from these tables for any condition by interpolation.

In order to treat a definite problem, we may assume the somewhat exaggerated condition of 80 amperes in wire A, 100 amperes in wire B, and 60 ampere in wire C, all supplying non-inductive, delta connected loads through conductors of 1.2 ohms resistance and 1.6 ohms reactance, with 1,000 volts between conductors at the generator. It is required to find the voltages at the loads.

The impedence of each line wire is the square root of the sum of the squares of its resistance and reactance, or $\sqrt{(1.2^2 + 1.6^2)} = 2$ ohms. The voltage drop in wire A for 80 amperes, whether leading, lagging or in phase, is the product of the impedance and the current, or $2 \times 80 = 160$ volts, which is measurable from the point (a) to the point (X) if voltmeter leads are sufficiently extended. Similarly the voltage drop due to the current in the wire B is $2 \times 100 = 200$ volts and the drop in the wire C is $2 \times 60 = 120$ volts.

In a graphical representation, we can plot the voltages at the generator to some scale as the sides of an equilateral triangle, abc as in Fig. 2. Circles drawn about the points a, b and c with radii equal, respectively, to 160 volts, 200 volts and 120 volts, will give the locus of the voltage drops in each of the three line wires, for all phases of current flow. For some particular phase relation of the current A and the voltage ab, the drop in voltage in wireA may be represented b ythe line aX_1. Then since in this problem the impedances of each of the three line wires is assumed to be equal, the three voltage drops must form a triangle

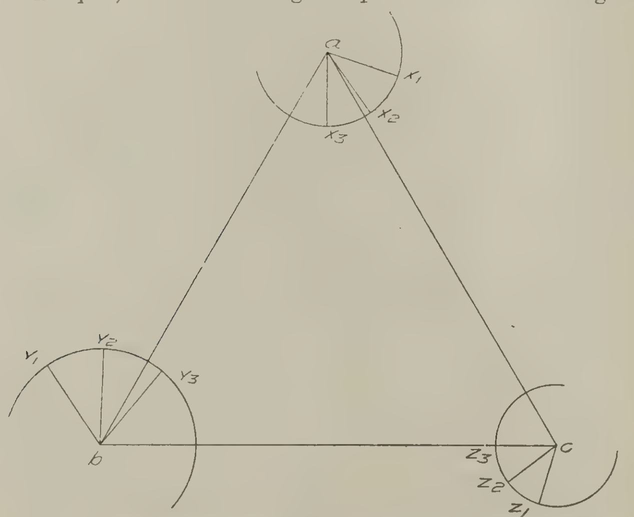

FIG. 2. REPRESENTATION OF GENERATOR VOLTAGES AND LOCI OF VOLTAGE DROPS IN THREE LINE WIRES OF FIG. 1.

similar in shape to the triangle representing the three currents, A, B and C. Corresponding to the drop aX_1, we have the drop bY_1, and cZ_1. Similarly for a drop aX_2, in wire A, the corresponding drop in each of the other wires is bY_2 and cZ_2; for a drop aX_3, we have bY_3 and cZ_3, etc.

There is an infinite number of possible cases, but for the three cases just taken, the voltages at the load are given by the length of the lines connecting X_1Y_1, Y_1Z_1 and Z_1X_1; or X_2Y_2, Y_2Z_2 and Z_2X_2; or by X_3Y_3, Y_3Z_3 and Z_3 X_3. The first of these cases roughly corresponds to a leading load; the second to a non-inductive load; the third to a lagging load.

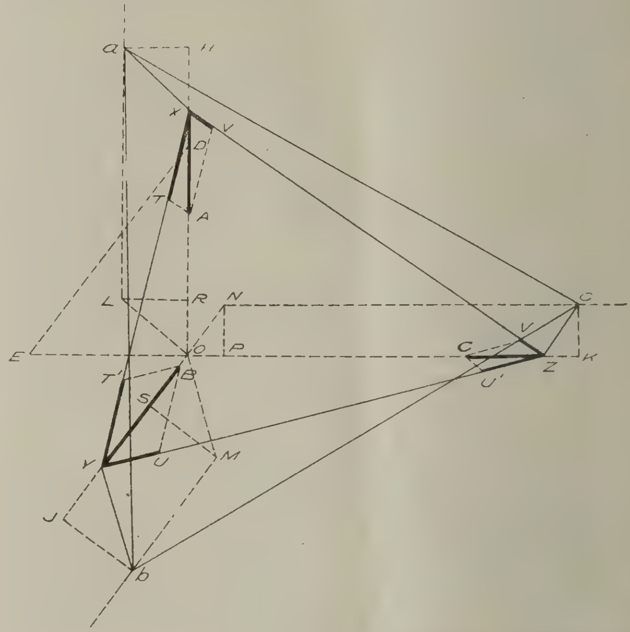

FIG. 3. GRAPHICAL SOLUTION OF VOLTAGES UNDER STATED CONDITIONS, NON-INDUCTIVE LOADS.

When we have a method for determining the position of one of these lines such as aX_1 for our particular problem, we have the problem solved. Fig. 3 shows the solution. To some scale as shown in Fig. 3, lay off a triangle DEO with sides OD, 80 amperes, DE, 100 amperes and EO, 60 amperes. The phase relation of the three currents is then given in direction but not in value by the lines OH, OJ and OK, indefinite in length, but drawn from the point O, parallel to the respective sides of the triangle DEO. The resistance drop in wire A, due to the current A, is in phase with OH and can be laid off to scale as OR = 96 volts. The reactance drop in wire A, due to the current A, is 90 degrees ahead of OH in phase and is laid off as RL = 128 volts (assuming counter clockwise rotation as positive). The impedance drop due to the current A, is OL and equals 160 volts. In similar way lay off OS equal 120 volts and SM equal to 160 volts, with OM equal to 200 volts to represent the drop in wire B due to the current B. Also lay off OP equal to 72 volts and PM equal to 96 volts with ON equal to 72 volts and PM equal to 96 volts with ON equal to 120 volts to represent the drop in wire C due to the current C.

Then draw La, Mb and Nc parallel respectively to OH, OJ and OK and indefinite in length. Upon these three lines it is necessary to construct the equilateral triangle abc, with sides equal to 1,000 volts. This may appear to be a difficult graphical construction but a cut and try method will give it after a few attempts. With dividers set for

1,000 volts, from some point (a) on La strike arcs intersecting Mb and Nc at some points (b) and (c). If bc is not found equal to 1,000 volts move the point (a) until the equilateral triangle abc is secured. This triangle represents the generator voltage. The drop in wire A is the line aX, equal and parallel to OL; the drop in wire B is bY equal and parallel to OM; the drop in wire C is cZ, equal and parallel to ON. The voltages at the loads are given by the sides of the triangle XYZ. By scaling the drawing in Fig. 3, we obtain the following results: XY = 710 volts, YZ = 880 volts, ZX = 825 volts.

It is interesting to carry the solution further and find the delta components of the currents. From X we can draw XA to some scale in phase with OH to represent the current in A or 80 amperes; from Y, draw YB in phase with OJ to represent the current B or 100 amperes; from Z draw ZC in phase with OK to represent current C or 60 amperes. The current XA may be resolved into 2 components XT and XV^1 in phase with the voltages XY and XZ; YB may be resolved into the components YT^1 and YU, in phase with the voltages YX and YZ; ZC may be resolved into the components ZU^1 and ZV in phase with the voltages ZY and ZX. Unless the currents XT equals YT^1, YU equals ZU^1 and ZV equals XV^1, we have made an error in the solution of the problem. The results as scaled from the drawing in Fig 3 are XT = 60.6 amperes, YU = 48 amperes, ZU = 20 amps.

Figures 4 gives the solution of a similar problem with the exception that the current in each of the delta loads is assumed to be lagging 30 degrees behind the electromotive forces. We proceed exactly as before, laying off our currents to phase OD, OP and OS, and our impedance drops OL, OM and ON. We then draw La, indefinite in length and 30 degrees ahead of OD in phase; Mb, indefinite in length and 30 degrees ahead of OS; Nc, indefinite in length and 30 degrees ahead of OP. The triangle abc, representing the generator voltage is then drawn and we find the triangle XYZ representing the voltage at the load. The currents XA, YB and ZC may be resolved as before into components which in this case are lagging 30 degrees behind the respective electro-motive forces. The results from scaling the drawing in Fig. 4 are:

XY = 650 volts, YZ = 780 volts, ZX = 810 volts, XT = 72 amperes, YU = 48 amperes, ZV = 18.5 amperes.

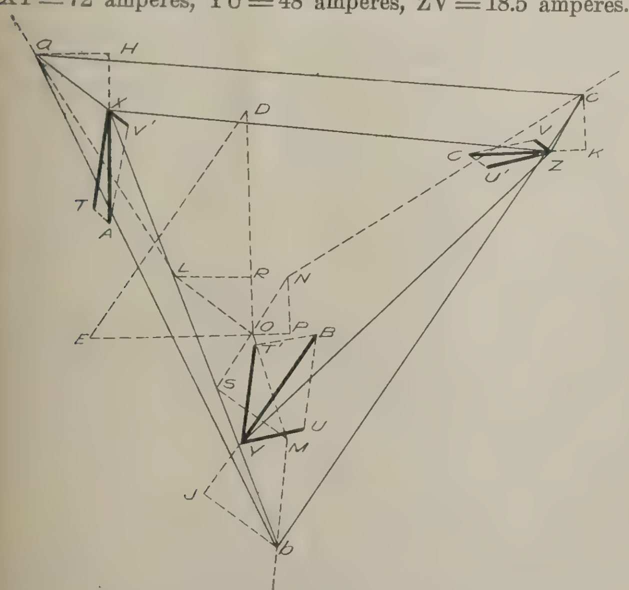

FIG. 4. GRAPHICAL SOLUTION OF SIMILAR PROBLEM TO FIG. 3 WITH CURRENTS LAGGING.

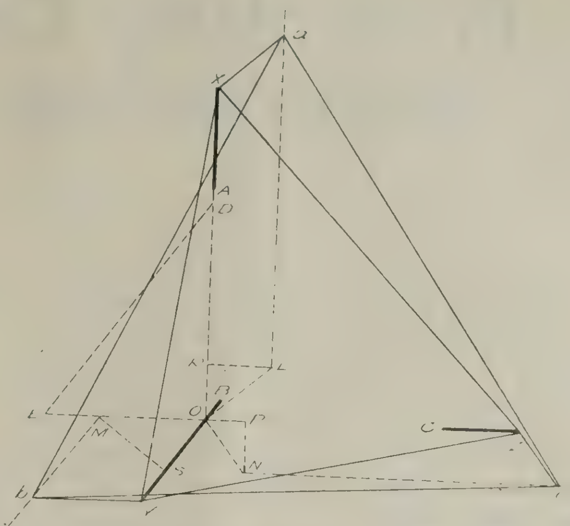

FIG. 5. GRAPHICAL SOLUTION OF PROBLEM WITH OPPOSITE PHASE ROTATION TO THAT IN FIG. 4.

The two foregoing solutions may appear to be definite and accurate. In assuming counter clockwise rotation as positive, we solved the problem as though the current A was in advance of C and as though C was in advance of B. Nothing is given in the original problem to indicate that this is the fact. Our current triangle DEO may be used equally as well to show the current A behind C and the current C behind B in phase, if we assume clockwise rotation as positive.

Using the same current triangle DEO, as before and assuming clockwise rotation we draw Fig. 5. The reactive drops are laid off in a direction opposite to that of Fig. 3 or 90 degrees ahead of the currents in a clockwise direction instead of in a counter clockwise direction. With exactly the same procedure in other respects we get a second solution for non-inductive loads from Fig. 5, corresponding with the solution of Fig. 3. In the absence of specific data as to phase rotation, the one solution is as good as the other. From Fig. 5, we find: XY = 790 volts, YZ = 720 volts, ZX = 864 volts.

Since the assumption of an opposite phase rotation gives dissimilar results in this case, one is lead to infer that when we have unbalanced loads there is a choice of two connections of the line wires to the generator, one of which may give better results than the other.

Power Project in Mexico.

Consul Wilbert L. Bonney, San Luis Potosi, reports the English company which has a concession to build a power plant on the Verde River at El Salto, State of San Luis Potosi, has closed a contract with the American owners of the adjacent land, which enables the company to proceed with work. It is proposed to develop some 40,000 horsepower. The fall, which is located near the boundary line of Tamaulipas and San Luis Potosi, has a height of about 260 feet, which, with the rapids above and below, is increased to nearly 400 feet. The river above the fall varies greatly in depth with the season, the stage fluctuating from 3 feet in dry times to 25 feet in flood. The fall is located near excellent agricultural districts, but distant from cities. It is proposed to transmit the power into San Luis Potosi, Matehuala, Tampico, and other centers, and it is understood that the controlling company has also secured other water rights and will include Monterey in its power system.

Public Policy Considerations for Public Service Corporations.

BY CHARLES T. BROWN.*

THE subject of public policy is one that is more and more important to business men as time goes on, and this is particularly true when applied to gas and electric companies. The public, while viewing all large combinations with keen suspicion that more profit is being made than is reasonable, and wrongs are being committed that should be remedied, looks upon quasi-public concerns as legitimate prey for newspaper attacks, legislative investigation and State control.

Until recently, practically all other kinds of industrial corporations were free to carry on business unrestricted and unhampered by State or National control. Such is not now the case and it is not wholly the fault of the State, nation or the people. It is the abuse of the privileges or disregard of the laws by some of the large corporations that has forced the people to call a halt, a thing that might not have been done had the rights of others been observed by these powerful concerns and had fair treatment and reasonable rates been the rule. The abuses by the railroads of the privileges they have had, and in some cases, a total disregard for law and the courts, were the causes that contributed largely to the enactment of the Interstate Commerce Law and the control of railroad rates by the Interstate Commerce Commission.

When considering gas and electric companies the attacks by the local authorities are more often the result of poor service and discourteous treatment than of high rates. There are numerous other complaints of less importance which are the fault of the corporation and there may be some things which are the result of sinister motives of designing persons and which contribute to the ill-feeling against the company but the latter are insignificant and will of themselves have little weight if the corporation will remedy the evils complained of and for which it is wholly to blame.

Accidents beyond control may interrupt the service, but if trouble is promptly and courteously explained, customers will be reasonable and fair, and possibly apologize for complaints, if any have been made. Prompt efforts to repair the break and explain the trouble, coupled with courteous treatment in all other matters, will soon convince the public that you are trying your level best to give good service. These things will be appreciated and redound to your benefit. Never say or insinuate that one most do business with your Company or not at all, not even though you have a monopoly of the gas and electric business in your city. It is not good policy and is bad practice. We are not the master, but we are the servants of both the company we represent and the people we serve.

Central station men are interested in numerous subjects, but none of greater importance than the one of public policy, for unless we work harmoniously with the public our business will not be satisfactory to our customers, our stockholders or ourselves. If the evils pointed out are real and not imaginary, may we not, to a great degree, apply a remedy without being forced to do so by the court, the city council or the legislature. Should we not have the family physician of common sense and justice diagnose our case and apply the Golden Rule remedy instead of being hauled off to the hospital to be cut to pieces by merciless butchers who have nothing to lose and know nothing of the troubles complained of or the remedy to be applied. Their custom is to cut and slash and leave you to recover as best you can.

The problem in hand is to combine our energies, both physical and mental, and earnestly work to put our corporations on a good, sound foundation, reorganizing operating departments in such a way that we will get the best results out of our men, our Company and ourselves. We must strive to give good service to our customers, insist on courteous treatment to every one, give prompt attention to every complaint without argument applying the remedy and doing it willingly. By making a friend of the man who makes a kick, we will soon have so many real friends among our customers that the whole community will believe in and stand by us, notwithstanding we may be attacked by yellow journals, demagogues and muck rakers.

Many of us may think the evils mentioned cannot be found in our own corporation, or at least not many of them, and in this regard we may be correct. Let us hope this is the fact. However, one of the first things we should undertake is good organization so we can operate our plant efficiently and economically. This can only be done by having competent men and a good system of operation. Men of the right sort are not always easy to obtain but it is not difficult to increase their efficiency if proper efforts are put forth by the management. An energetic man of average ability can increase his efficiency very rapidly if he is coached and encouraged, and it will always repay the employer as much as it will benefit the man. The man who does his work well, or as well as he honestly can do, who is painstaking, careful, industrious, reliable and eager to carry responsibility will never be without employment. Such men are always in demand. But the others, the ones who watch the clock, who do just what is required of them, who do no extra work except when given extra pay and work for their wages and not for their employer, these are not the men who bring us good results and help us acquire or maintain a good standing with the public. This condition can be remedied to quite an extent by the management, and what is meant by the management is not the board of directors, but the active head in charge of the business affairs of the company.

Should the directors of the company place a man in charge of the affairs who will first apply the rule of efficiency to himself and then to his subordinates and create a desire to increase the efficiency of all for the good of each and the benefit of the company, they in turn will influence

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the other men of the organization and make them feel and know that the better they perform their respective duties, the better citizens they will become and the more likely will be their promotion if an opportunity offers. One thing should be remembered, that the man who is afraid of doing more than he gets paid for doing, never gets paid for anything he does not do. There never was a time in the history of the world when efficiency, courage and ability would sell for as much as they will today. The higher the salary the fewer the applicants and the lower the pay the more numerous the men. There is probably no position filled by men in the affairs of corporations, be those concerns large or small, where efficiency means so much as in the management. If the manager does only what he is required to do by the directors and keeps his affairs in fairly good order, does what he deems necessary in order to draw the salary agreed upon, gives the usual excuses for things that are not turning out as expectetd, explains why his previous estimates have not been realized and on the whole does fairly well, and some one else wants to employ him, the directors give him a good letter of recommendation and possibly tell him that they regret he is not remaining with them and hope he will succeed and be happy in his new position. They know they will have little difficulty in filling his place and immediately set about to do it. No one can criticise the man who has just resigned for he has done just what he was expected to do. Many others can do as much. The directors are not disconcerted, in fact, they may be hopeful that the next man will do better and offer fewer explanations and make excuses less numerous. The other kind of a man, the one who does more than is required, produces better results than his estimates, offers no excuses and admits of no failure, who keeps his directors fully informed concerning what his company is doing and makes careful estimatets of the future and guards against accidents, has the co-operation of his subordinates and gets the best results from his men. If and when this man indicates a desire to resign and says he is offered a better position somewhere else, the directors ask themselves what they will do if he leaves. He has woven himself into the affairs of the corporation to such an extent that he is a part of it. He has the responsibility on his shoulders and seems able to carry the load, he has every detail on the ends of his tongue and fingers, he has the confidence of the public and of his men, he has the faculty to build up the efficiency of his entire organization, the community in which he lives recognizes his ability as a manager, and the stockholders, through the directors, have heard and know about his excellent management. The first man mentioned did what was required of him, the second man did all he could and made himself practically indispensible. Men like the latter are few in number and are extremely valuable, they are almost invaluable and yet there is not a manager who cannot, to a marked degree, approach this state of efficiency if he will apply himself in an energetic way and with a thorough determination to master his subject. There may be exceptions, but very few.

The general public looks upon the general manager of a public service corporation as the company, and if he is personally popular and well spoken of and impresses everyone as being capable, honest and sincere the public will soon draw the conclusion that the company he represents is honest and sincere in its business methods and as his popularity grows the danger from public agitation and regulation will decrease. Furthermore, a live manager means a live company in fact also in the eyes of the public. One arbitrary manager or head of department, on the other hand, can do more harm than all the good that can be accomplished by the united efforts of the rest of the organization. What is meant by "arbitrary" is the man who prejudges and without giving the complainant an opportunity to present his case decides it and possibly creates an enemy. He should be conciliatory and never arbitrary, and at the same time, he should be firm.

Within the past few years we have heard much reference to scientific management, and it is now a popular study among large business men. According to Taylor "the principal object of scientific management is to secure a maximum prosperity for the employer coupled with the maximum prosperity for each employee." Without discussing this question from a theoretical viewpoint, it seems apparent that it is a grave duty upon every manager to see that his employees are properly treated, that they live under the best and most sanitary conditions, and above all that every one of them be given the opportunity to earn the maximum wage of which he is capable, mentally and physically. The employees of our company are our personal charges and to ignore their welfare is an incentive for dissension in our ranks, and possible agitation from the outside.

While the foregoing remarks are directed to the management and to the manager particularly, they also apply all the way down the line to the office boy and to the man who works by the day at common labor. Your management should put good men in charge of every department and induce them to strive for good service to the public, for good service is more important than low rates. Ill treatment of a customer will hurt you more than it will harm him, while his good will is oftten worth more to you than his money.

The gas and electric companies are the largest concerns in all cities and we are especially interested in the welfare of the entire community. Keep the leading men advised, in a general way, of what your company is doing and how it is getting along. Ask for their advice about things contemplated and be sure and get every criticism of methods and management, so as to consider and improve wherever possible. The central station companies should be educators in every city. There is no other concern that is in such close touch with every enterprise and industry in the entire country. We are in practically every street with our mains and lines; our men are in all parts of the city every day and we know some member of every family. We are, therefore, in a position on account of our extensive organization, and our influence, to do more good in the way of setting an example for the other business concerns of the city to follow than any other factor in the community, excepting none. Show the business community what we can do in the efficient operation of our business, get close to the big men, advise with and give suggestions to show them how they can extend their business, impress on our wholesale men and manufacturers that while we are confined in our business operations to the territory covered by our lines and mains, they have the whole world as a market; that we want the city to grow and that we want them to help us induce new enterprises to come so they and ourselves can sell more of our respective products; convince them that if we all work together harmoniously and pull in the same direction at the same time, we can double the population every twenty years and increase the business to even a greater extent.

It is a good plan to take the people into our confidence and have our position, in a general way, understood. Most of the people and practically all of the prominent men in our cities will be willing we should earn a fair return on our investment. This means that they will concede we should sell our product at reasonable rates and make a living profit. If we hold back and say nothing about our affairs, some one else will begin to talk and if he is unfriendly, his remarks will neither be flattering nor fair. Many will believe what he says and then our real trouble begins. To avoid all this we should keep in close touch with the prominent business man and if we are doing what is fair and reasonable, they will do more than we can possibly accomplish to counteract the evil and untrue statements that some unscrupulous man or newspaper may make.

Increased volume of business enables the making of lower rates. Lower rates, on the other hand, enable the public to purchase increased volumes of gas and electricity. It should, therefore, be the policy of every company to reduce its rates to as low a point as is consistent with absolute cost and the increased volume of business which they will secure at lower rates will bring in more net profits, will render the company safer from rate regulation and other forms of agitation, and will do more to insure the permanent prosperitiy of the company than any other policy we can adopt. The old system which was once the rule adopted by railroads to charge a high rate for a small tonnage has been abandoned, and the more modern plan of increased tonnage and reduced rates is the rule. Likewise, among gas and electric companies, the day is past when they can hope to be and remain prosperous by doing a small volume of business at high rates, and such companies are inviting future just criticism, which may end disastrously.

Principles of Illuminating Engineering.

(*Contributed Exclusively to* Southern Electrician.)

A. G. RAKESRAW.

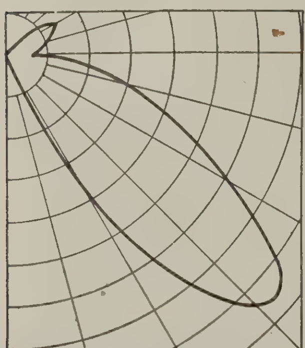
Illumination Considerations for Carbon Arcs, Light Distribution and Efficiency.

IN this article the writer proposes to consider the general illuminataing qualities of carbon arcs, such as the quality of the light, the efficiency and the distribution. In general these features depend upon the reflectors used, the glass employed for the inner and outer globes, and the adjustment for current and arc voltage. The color of the light is dependent upon the length of arc and the current density at the points of the electrodes. The old open or short arc which required only 45 volts at the arc gave a practically white light, while the enclosed arc which is much longer, taking 80 volts at the arc, is of a violet hue.

The curves given herewith show the light distribution from direct and alternating current arcs, with different globes. It will be noted that the distribution zone of the D. C. open arc is very narrow, thus making a great difference between the maximum and the mean candle power. In fact, until comparatively recently, all arc lamps were rated in maximum candle power and this value was taken under the most favorable conditions, and as a consequence the results gave an entirely erroneous idea of the illuminating value. For instance in the case of a D. C. open arc of 9.6 amperes, the maximum candle power is 1,250 at 45 degrees, the mean hemispherical candlepower 690, and the mean spherical 460 candlepower.

It will also be noted that the distribution of the A. C. open arc without reflector is very poor, since owing to the absence of any crater almost half of the light is thrown in the upper hemisphere and in many cases totally wasted. If a properly designed reflector is used, a good deal of this light can be saved, or if indoors by reflection from the walls and ceiling. A specially designed reflecting surface for this purpose has been termed a concentric diffuser.

In table No. 1 the values of the current, voltage, watts, candle power and efficiencies are given for several different types of carbon arc lamps, being average values compiled from several standard authorities. It will be noted that the series arcs are more efficient than the multiple arcs, because



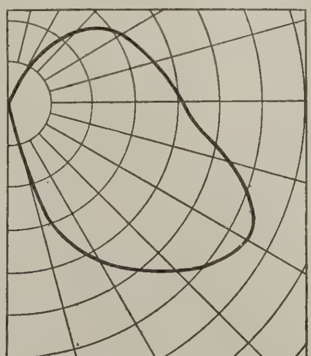


Fig. 1. Distribution from D. C. Open Arc Lamp with Clear Globe; Fig. 2. D. C. Enclosed, Opal Globe.

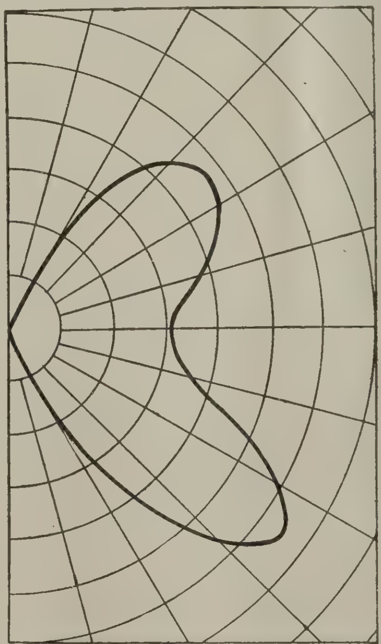


Fig. 3. Distribution of A. C. Open Arc with Clear Globe.

while the candlepower and the watts in the arc are about the same, yet there is a necessary waste of energy in the steadying resistances used where arcs are operated in multiple. For instance in the D. C. multiple arc, while the terminal voltage is 110, the volts in the arc is but 80 and the watts in the arc 400. This means that out of 550 watts, there are 150 absolututely wasted. The series lamp has a terminal voltage of about 75, with 73 volts in the arc, showing a much smaller waste. It is to be noted further that the D. C. arc is more efficient than the A. C. of the same service. This is due to the fact that in the D. C. arc we have the crater of the positive carbon as the principal source of light, giving 85 per cent of the whole, and operating at an extremely high temperature and therefore high efficiency. In the A. C. arc, since the current is constantly reversed no such crater can form, and the efficiency of radiation is lower. The open, the enclosed and the semi-enclosed arcs may be also compared in Table 1, as to the relative life and efficiencies.

The effect of varying current values in the D. C. multiple enclosed arc is given in Fig. 5, showing the candlepower and efficiencies. The candlepower values seem to bear a straight line relationship to the watts expended. The dotted part of the curve is, of course fictitious, but seems to indicate that these curves would all meet at a point corresponding to an input of about 200 watts. The watts per candlepower seem to approach a minimum value, indicating that there is practically nothing to be gained by pushing the current above about 7½ or 8 amperes.

There are special forms of carbon arcs which should be briefly considered. In order to secure the advantages of indirect illumination without having the rays of light intercepted by the body of the lamp, and without having to undergo the loss due to double reflection, one manufacturer has produced an inverted arc lamp, in which the mechanism is below the arc instead of above. Fig. 6 shows this lamp.

In order to increase the current density in the carbons and thus improve the color of the light, the intensified arc lamp has been introduced. The principle is the same as any enclosed arc lamp, except that it uses two small upper carbons and one lower carbon, arranged as shown, by the dotted lines in Fig. 7. The upper carbons are ¼-inch in diameter and are brought obliquely into contact, burning away against each other and thus keeping the position of the arc constant. The lower carbon, which is ⅜-inch in diameter, is fed upwards by means of the ordinary series magnet mechanism. The constant position of the arc is an advantage, since it permits the most effective use of globes and reflectors. In the ordinary enclosed arc, the position of the arc changes as the lower carbon burns away, and where accurate focusing has to be done, manual adjustment is necessary, unless some special arrangement is used. The small diameter of the positive carbons in the intensified arc

TABLE I. PROPERTIES OF CARBON ARC LAMPS.

Kind of Lamp.	Amp.	Volts. ext.	Volts. Arc.	Watts.	M. S. c. p.	M.H.S. c. p.	Watts per m. s. c. p.	Watts per m. h. s. c. p.	Hrs. Life	Carbons, etc.
Open D. C. Series—clear outerglobe	6.6	50	48	330	265	395	1.25	.82	18	2 prs. ½″ round
Open D. C. Series—clear outerglobe	9.6	50	48	480	460	690	1.02	.71	18	2 prs. 5-8″ round
Open D. C. Mul.—2 on 110 V	9.6	55	48	528	389		1.35		14	
Open A. C. Mul.—2 on 110	15	55	48	530	300		1.77		13	
Semi-Enclosed—reflector and D. C. Miniature—opal inner	4.1	110	83	451	218	332	2.06	1.36	50	¼″ carbon
Enclosed D. C. Multiple—no reflector, opal inner globe	5	110	80	550	220	276	2.5	1.98	100	
	6	110	80	660	290	365	2.27	1.81	to	½″ x 12″ carbon
	7	110	80	770	358	450	2.15	1.71	150	
	8	110	80	880	425	535	2.07	1.64		
D. C. Series—reflector, clear globes	6.6	75	73	495	290	479	1.71	1.03	125	½″ x 12″ carbon
A. C. Multiple—no reflector, opal inner globes	4	104	72	287	90	105	3.19	2.73		
	6	104	72	430	167	188	2.57	2.28	100	½″ x 12″ carbon
	7.5	104	72	540	225	255	2.4	2.12	to	
	10	104	72	720	320	363	2.25	1.98	125	½″ x 12″ carbon
A. C. Series—clear globe	6.6	77	72	425	144	232	2.95	1.83	125	½″ x 12″
A. C. Series—clear globe	7.5	77	72	480	173	291	2.77	1.65	100	
Enclosed Intensified—reflector and opal inner globe	5	110	80	550	225	414	2.44	1.33	80	2 upper ¼″, 1 lower 3-8″

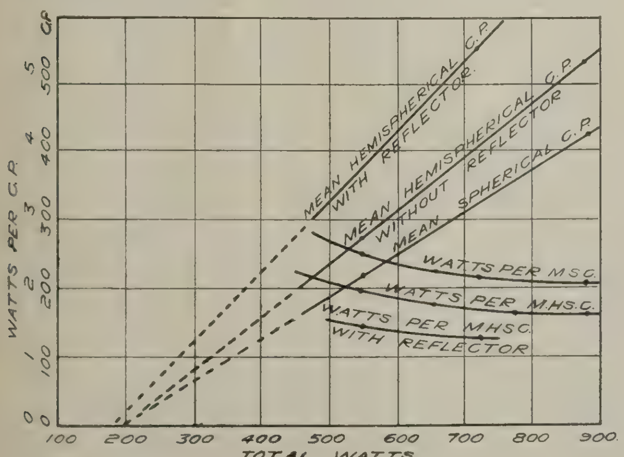


FIG. 4. EFFECT OF VARYING CURRENT VALUES IN D. C. MULTIPLE ENCLOSED ARC.

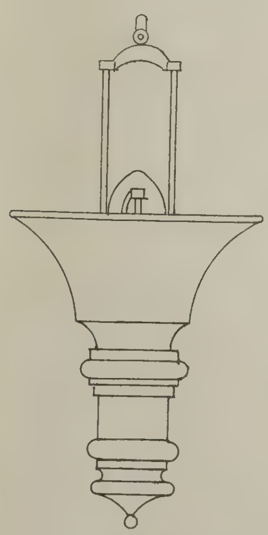


FIG. 6

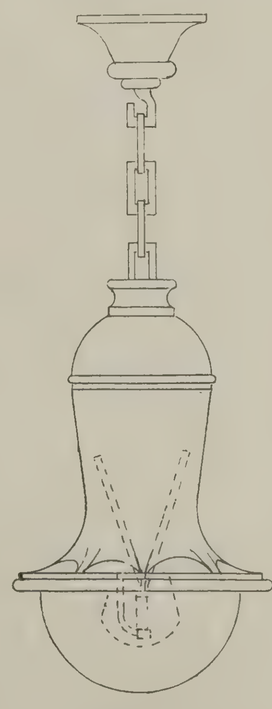


FIG. 7

FIG. 6. INVERTED ARC LAMP; FIG. 7. INTENSIFIED ARC LAMP.

also prevents the wandering of the arc and consequent unsteadiness of light experienced with larger sizes of carbons. The color of the light from this arc is practically white, being much better than either incandescent or gas lamps.

The ordinary vertical carbon arc lamp loses a good deal of light owing to the fact that the positive crater which is the principle source of light, is more or less obscured by the other carbon. Of the total light emitted, the crater gives 85 per cent, the other hot carbon 10 per cent and the arc itself 5 per cent. In order to obviate this loss, the carbon lamp has the two carbons inclined to each other, similarly to a flaming arc, the arc being elongated and deflected downward by blowout magnets.

Another peculiar form of the carbon arc is that of the old Jablakoff "candle," which, however, is seldom seen outside of an experimental laboratory, as it is not made commercially. In this lamp the two carbons are placed side by side, being separatetd by a thin strip of non-conducting plaster. After some means has been used to start the arc, it will be maintained without any regulation whatever. The impractibility of any automatic devices being used for this purpose has kept the lamp from being commercially successful. Quite lately, however, experiments have been made in which the plaster is mixed with a small quantity of copper. Upon the interruption of the current some of this copper is deposited, forming a slender conducting bridge from one carbon to the other. Upon the current being again applied, this thin metal film is fused, starting the arc again. This makes the simplest form of arc lamp possible. In case the carbons were vertical or horizontal no regulating mechanism whatever would be required, while if they point down-

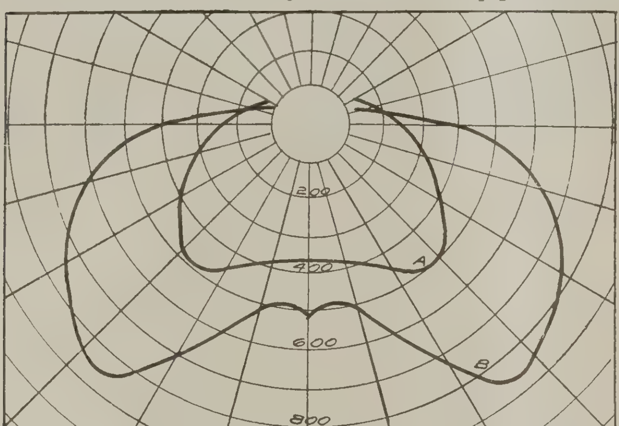


FIG. 8. DISTRIBUTION CURVES FOR INTENSIFIED ARC, A WITH OPAL INNER AND CLEAR OUTER GLOBES, B WITH CLEAR INNER AND NO OUTER GLOBES.

wards, it is only necessary that they burn away against some kind of a pin or stop.

The advantage of the open arc lies in its brilliancy, while that of the enclosed arc is in its long burning hours. In order to secure some of the advantages of both, use has been made of an enclosing globe which allows a limited amount of air to reach the carbons. Plain carbons are used, the one being cored and the other solid. The result is a lamp occupying a middle position between the open and the enclosed, giving a fair performance. In the smaller sizes this lamp is called the miniature arc, and takes 2 or 3 ampere with from 150 to 350 lower hemisperical candlepower. The net efficiency is about the same as the tungsten lamp, by which it has been largely superceded.

The general application of carbon arcs has been considerably narrowed down of late. The tungsten lamp is almost entirely supplanting it for interior use in stores, while the flaming arc is taking its place for spectacular outside display. The magnetic arc has demonstrated its superior qualities for regular street lighting, and while the carbon arc has occupied an almost unquestionable place for factory lighting, yet the mercury vapor light, and to some extent the flaming arcs are beginning to be used for this purpose also. In fact while the arc lamp has had a general field of application next to the incandescent lamp, it is a question whether it is not likely to be largely superceded by other kinds. The great advantages of the carbon arc are its very low maintenance charges, and where power is secured at a low rate, such as in a factory where it is generated on the premises at a cost of one cent per K.W.H. or less, the efficiency becomes of secondary importance. It is also very rugged in construction, will stand considerable abuse, and probably be used in factories for a long time.

Increasing Use of Electric Furnaces.

Prof. McWilliams, of the Sheffield University, in a report prepared for the meeting of the British Association at Portsmouth, gives some interesting figures relating to electric steel production. Up to June, 1910, there were about 118 electric furnaces of all types, of which 70 were in use, 10 were not working and 38 were being built. The total capacity of all electric furnaces was 350 tons per charge. In June, 1910, there was 29 Heroult furnaces with a capacity of 80 tons in use and furnaces of 30 tons in course of erection, while in June, 1911, there were 43 furnaces with a total capacity of 242 tons.

The output of electricsteel in Germany, the United States, and Austria-Hungary in 1910 amounted to almost 112,000 tons, which is an increase of 53,000 tons over the figures of 1909. Those are the only countries for which the exact output of electric steel is published; probably the figrues for Sweden, France, Belgium, and Italy would also show large gains. The increase will likely be more than maintained in 1911, as more than 30 new furnaces of various types will be started during the year and many that started toward the end of 1910 will put in a full year's work in 1911. England will also, for the first time, appear as a regular producer, with an output of about 13,000 tons.

At present the two 15-ton Heroult furnaces at Chicago and Worcester, belonging to the United States Steel Corporation, are the largest in operation. This corporation has recently acquired the Heroult patents for America and will probably erect several new furnaces shortly.

The electric furnace can be used either for melting scrap directly or in combination with some other form of furnace, in which latter case it acts simply as a refiner. The majority of the recent furnaces have been employed as refiners in conjunction with either a Bessemer or an openhearth furnace. The latter is usually of the basic or tilting type, part of the charge being removed to the electric furnace after the pig is melted and the bulk of the phosphorus removed, leaving some phosphorus and the oxygen and sulphur to be eliminated by the electric furnace. The time required is from one to two hours according to the degree of refining required and the condition of the steel when removed from the basic furnace. The power used varies from 100 to 300 kilowatt hours per ton. When cold scrap is melted the time required is about six hours and the power consumption said to be from 650 to 750 K. W. hours.

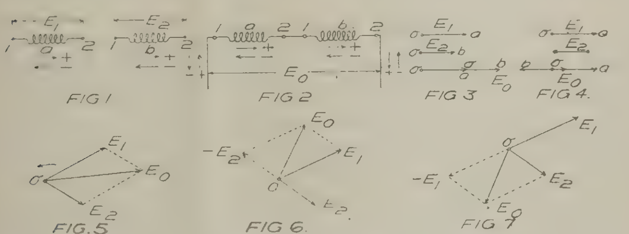
Analyzing Electrical Problems Showing Graphical Solutions.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)
BY FRANK FOWLE, CONSULTING ELECTRICAL ENGINEER.

THE connection of two or more sources of alternating electromotive force in series with each other often produces some difficulty in determining the relative phase position of the resultant e. m. f. The student, especially, finds this problem perplexing in some cases. The resolution of e. m. f.'s whose phases are coincident or in perfect conjunction is extremely simple, and the same is true if the phases are in complete opposition, or a half cycle apart. The resultant is then the algebraic sum of the components and the phase of the resultant is evident from its sign. This applies, of course, to e. m. f.'s of the same frequency and simple sine wave shape; such waves are the only ones hereafter considered.

The difficulties, which may arise, occur when the components are displaced in phase and the sources connected in various ways There are two methods in common use for studying such conditions and each method is susceptible of analytical or graphical treatment. The latter is of great advantage in treating the principles involved, because it is readily grasped; and not infrequently it is serviceable in obtaining quantitative results. The first general method is based on the use of instantaneous values, with the aid of the familiar sine curves. The second is the vector method, in which the effective value is shown in magnitude and phase position by means of a polar diagram. A combination of these methods is very useful to any one in obtaining a full grasp of alternating current problems.

The simplest case to consider is that of two sources of e. m. f., such as the coils shown in Fig. 1. The terminals of these coils are numbered for reference; and it is neces-



FIGS. 1, 2, 3, 4, 5, 6 AND 7. DIAGAMS SHOWING VECTORIAL REPRESENTATIONS.

sary then to adopt a convention in reference to the direction of the positive half of the wave which issues from each coil. The first or positive half will be assumed in every case to flow, within the source, from the lowest numbered treminal to the highest. That is, the highest numbered terminal will be positive as regards the first half of the e. m. f. wave impressed upon the external circuit. But in order to determine whether the component of impressed e. m. f. is positive, it is necessary to adopt a further convention with respect to the direction around the external circuit which shall be taken as positive for the first or positive half-wave. It makes no difference which direction is chosen, but when once fixed, it determines whether any component of the resultant is positive or negative. The general relationship of two emf's as shown in Fig. 2, is,

$$E_0 = E_1 + E_2 \qquad (1)$$

This is most obvious, of course, when the components of the resultants are completely in phase with each other. For example, if $E_1 = 100$ and $E_2 = 75$, the resultant is $E_0 = 175$. If one coil is reversed, b, for instance, its sign becomes negative and $E_0 = 25$. If a is reversed, instead, then $E_0 = -25$, and if both coils are reversed, $E_0 = -175$.

When the previous problem is treated graphically, the procedure is varied slightly. Referring to Fig. 3, the line oa represents the e. m. f. E_1 in magnitude and relative phase position, and similarly the line ob represents E_2, when connected as shown in Fig. 2. The resultant is equal to the line oa plus ob, as shown. When coil b is reversed the resultant is either the sum of E_1 and E_2 or the difference obtained by subtracting E_2 from E_1 as shown in Fig. 4. If the sign of E_2 is taken always as positive, the criterion of whether to add or subtract is found in the manner of connecting coil b with reference to the external circuit.

All this is quite simple and the case, which will be considered at greater length, arises when the component e. m. f.'s differ both in magnitude and phase. The expression (1) is perfectly general, if it is interpreted to mean vector addition when the phases are displaced with respect to each other. Let it be supposed that the coils a and b are connected as shown in Fig. 2, and that their respective e. m. f.'s are given in Fig. 5. The component E_2 is assumed to lag in phase with respect to E_1 as shown by the direction of the arrow which represents positive rotation. The vector sum of E_1 and E_2 in Fig. 5, is given by E_0, which is the graphical representation of expression (1). Under these circumstances it will be observed that coils a and b are so connected (in series) that their positive half-waves of e. m. f. tend to send a current in the same direction, and also in the positive direction around the external circuit. The resultant E_0 will always be the vector sum of E_1 and E_2 under these conditions. By varying the phase position of E_2 in Fig. 5, the components can be brought into phase, or placed in exactly opposite phases 180° apart. These two conditions cover cases first considered.

The reversal of coil b will reverse the phase position of E_2, with respect to E_1, and the external circuit. Hence the resultant will be the sum of E_1 and E_2, or the remainder when E_2 is subtracted from E_1, which amounts to the same thing. This is shown in Fig. 6. The reversal of coil a instead of b will give a resultant which is illustrated by Fig. 7, and amounts to a complete reversal of the resultant given in Fig. 6. The reversal of both coils will give a resultant exactly the reverse, or 180° from that which appears in Fig. 5, as shown in Fig. 9.

It may be deduced from this that the rule for combining two vector e. m. f.'s, serially connected, is as follows: Given the vector e. m. f.'s and the positive terminal of each source for its positive half-wave, the vectors should be added

when the sources are so connected that the positive half-waves flow in the same direction, and subtracted when oppositely connected; either vector is positive with respect to the evternal circuit when its source is so connected to the latter that it tends to send the positive half-wave around the circuit in the conventional positive direction. Those who desire to do so, can follow out these relations by means of sine curves which show instantaneous values, instead of the vector effective (or maximum) values. Such an example is given in Fig. 8, which corresponds to the vectors in Fig. 5.

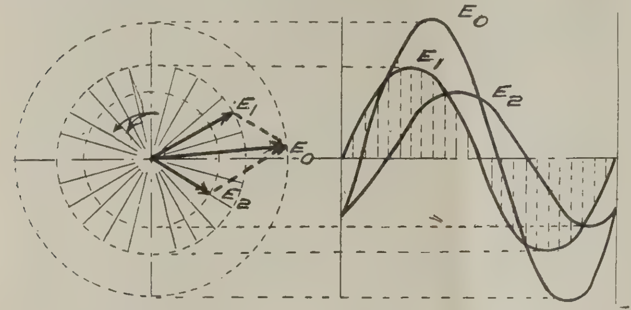


FIG. 8. DIAGRAM SHOWING RELATIONS BY SINE CURVES INSTEAD OF VECTOR VALUES. THIS CASE CORRESPONDS TO VECTORS IN FIG. 5.

When more than two sources are serially connected in any manner, the effect of reversing components can be stated in the following general terms: If $m+n$ sources are serially connected, of which m sources are positive and n are negative, the effect of reversing all the sources will be to reverse the resultant, where m and n have any values, and their e. m..f.'s any magnitude and phase relation. Obviously m sources of one sign will give a single resultant, which can be reversed by reversing all the m sources; and the same is true of the remaining n sources of opposite sign. The resultants of each group, when resolved vectorially, give the final resultant; and a reversal of the two final components reverses the last resultant, as illustrated by Fig. 9.

One of the important cases which arise in the resolution of vector e. m. f.'s occurs in the case of a star-connected three-phase generator, or transformer bank. Fig. 10 shows a star (or Y) connected generator feeding a three-wire line and thence into a delta connected receiver. The three generator coils, *a, b* and *c,* are so connected that the positive half-wave of e.m. f. in each case tends to send a current from the neutral *o* to the respective phase-wire. Hence any two generator coils, taken in series, are connected so that they tend to oppose each other and the resultant e. m. f. of any two coils will be found by vector subtraction, rather than addition. The respective e. m. f.'s of coils *a. b.* and *c* are E_1, E_2 and E_3, as shown in Fig. 11. The resultant of E_1 and E_2, assuming that the outward direction of current on phase-wire 1 is positive, is E_{12}, as shown in Fig. 11. Similarly the resultant of E_2 and E_3 is *23,* and the esultant of E_3 and E_1 is E_{31}.

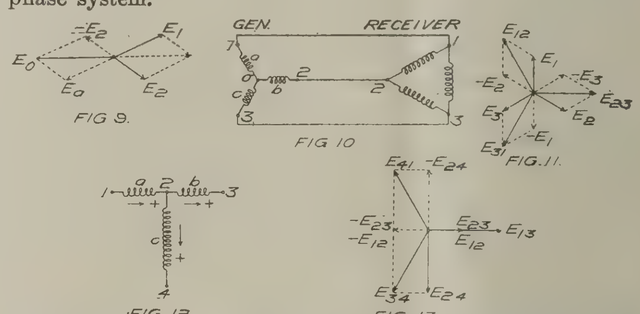
The vector sum of the component e.m. f.'s, taken serially in conjunction, is zero, assuming that they are equal in magnitude and one-third of a cycle or 120° out of phase. The same is true of the vector sum of the resultant e. m. f,'s, taken in the same way. The resultant E_{12} is impressed on the receiver coil *12,* and similarly for the others. A similar diagram exists for the respective currents, but the line current, per phase-wire (Y current), exceeds the delta current. The well-known relationship between their relative magnitudes is—

$$E_{12} = (\sqrt{3})\ E_1 \qquad (2)$$

$$I_1 = (\sqrt{3})\ I_{12} \qquad (3)$$

where the system has a balanced load and is symmetrical. When the various relations in such a system are not readily grasped, it will generally be helpful to revert to the sine curves of instantaneous values, in conjunction with the vector diagrams.

Another interesting and practical case occurs with phasing transformers for converting from two-phase to three-phase, or vice versa. Two transformers are required and on the three-phase side are connected as shown by Fig. 12. The coils *a* and *b* constitute the secondary of one transformer, with a tap brought out at the electrical center of the winding. The secondary of the other transformer *c* is connected from the centre tap of the phase wires. The value of E_{24} is 86.6 per cent of E_{13}. The component e. m. f.'s and their resultants are given in Fig. 13. The components E_{12} and E_{23}, assuming terminal *3* to be positive, are added together and form E_{13}. The components E_{23} and E_{24} assuming terminal *4* to be positive, are resolved by subtracting the former from the latter, which gives E_{34} as the resultant. The components E_{12} and E_{24}, assuming terminal *1* to be positive, are resolved by reversing both and then adding them, which gives E_{41} as the resultant. The three resultants are the delta e. m. f.'s of a symmetrical three-phase system.



FIGS. 9, 10, 11, 12 AND 13. DIAGRAMS SHOWING THE SOLUTION OF PRACTICAL CASES.

It may be observed that the methods described rest upon certain conventions adopted in the premises of each case. A reversal of conventions will likewise reverse the results, but does not alter the various relations as a whole. Obviously the choice between two conductors in a single-phase alternating current circuit, as to which shall be taken as positive, depends upon which half-wave of e. m. f. is considered. It is only important to emphasize that in any given problem the conventions must be consistent and rigidly adhered to.

The practical problem of connecting polyphase e. m. f. sources in the correct manner can usually be solved with a suitable voltmeter and a little experimentation in measuring the e. m. f.'s of each separate source, and their resultants when combined in various ways. By a little consideration of the results thus obtained, the proper connections can usually be found with little difficulty.

Germany, the first country to adopt electric fire engines, has again scored in pioneering the electrically-driven street scrubbing automobile. The little city of Schoenberg has ordered twelve such street scrubbers, all of which are to be in service by the middle of the coming summer.—*Popular Electricity.*

Alternating Current Engineering.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY WILLIAM R. BOWKER.

The Application of Auxiliary Starting Devices to Induction Motors.

WE will now consider the auxiliary starting device generally employed with the squirrel cage short cirsuited rotor type of motor, the auto-transformer or compencuited rotor type of motor, the auto-transformer or compeneach phase, which single coil serves both as a primary and secondary. This compensator is connected in the stator circuit, and usually consists of two coils for two phase, and three coils for three phase, wound upon a laminated iron core. The windings are provided with a number of taps or connectors, so that the motor current may be obtained at secondary voltages of variable values, less than the full line impressed voltage. The voltage most suitable for any particular starting torque is connected to the motor side of the switch.

The following table shows the effect of e. m.f., starting current, and starting torque at different voltages expressed in percentages of full load.

E. M. F.	Starting Current. from line.	Starting Torque.
40 per cent	112 per cent	32 per cent
60 per cent	250 per cent	72 per cent
80 per cent	450 per cent	128 per cent
100 per cent	700 per cent	200 per cent

The current flowing between the compensator and motor will be greater than the line starting current, for its voltage is lower, the action of the compensator being similar to that of an ordinary transformer. The following explanation should be thoroughly understood.

In the design of the auto-transformer the compensator windings should be so designed that each section composing the continuous coil as a whole for several voltage taps, should have an ampere capacity to conduct the normal current that results from any particular voltage on the compensator, resulting from the taps, and as determined by the impressed line voltage and transformer action of the sectional windings. In one section of the windings the current and copper capacity will be equal to the high tension current, while in the other section of the compensator windings the current will be equal to the difference between the high tension current and low tension current.

It should be understood that the continuous compensator windings, divided into sections by the voltage taps, can be conveniently considered as composed of two coils giving a high tension or primary and secondary transformer action. The high tension winding is designed for the resulting high tension current caused to flow by a voltage equal to the difference between that of the high tension and low tension sectional windings, while the low tension winding is designed for a low tension voltage and a current equal to the difference between the low tension current and high tension current. The watt rating of each of these different sections of the compensator windings is equal in each case.

Owing to its transformer action, the compensator can be considered as an ordinary transformer, built of a primary and secondary winding, in which the magneto-motive-force of the current in one section of the windings is opposed magnetically to the magneto-motive-force in the other section. If a compensator, that is, an auto-transformer, is not used for starting, the motor will require from six to eight times full load current and exert from 1 1-2 to 2 times full load torque.

The output of an induction motor varies with the square of the impressed voltage at the motor terminals. For example, if the terminal voltage happens to be 15 per cent of its rated output, will give only $(85/100)^2 \times$ motor which at the rated voltage gives a maximum of 200 per cent of its rated output, will give only $(85/100)2 \times 200 = 144$ per cent of its rated output. Compensators are usually supplied connected to the tap giving the lowest torque. If the motor will not start its load, the next higher voltage taps should be tried, and so on, until the taps are found that give the required torque. The compensator taps are so connected that the first tap impresses the lowest full load current in the line and exerts about 30 per cent of the full load torque. On the second and other taps both current and torque are increased, owing to an increased impressed motor terminal voltage.

Compensators for use with motors of 15 horse power and under, usually have three taps giving voltages of 40 per cent, 60 per cent and 80 per cent of full line impressed voltage. For motors above 15 horse power,four taps are provided at 40, 58, 70 and 85 per cent of full line voltage. The compensator switch also serves as the main line switch, so that separate line switches are not necessary, the motor terminals being "dead" when the compensator is in the "off" position. The proper tap for giving the maximum starting torque without causing an inconvenient voltage disturbance in the supply circuit, can be ascertained by experiment, and connected to when installing the motor. The switch should be kept in the starting position until the motor has finished accelerating and attained full speed, so as to prevent any unnecessary rush of current when the switch is thrown over from the starting to the running position. The current diminishes rapidly as the speed increases.

A well known make of compensator provides taps for motors from 5 to 18 horse power, starting the motor at 50, 65 and 80 per cent of the full impressed line voltage, with respective line currents equal to 25, 42 and 65 per cent of the current that would be taken by the motor, if no compensator were used. For motors larger than 18 horse power, compensator voltage taps are provided giving voltages equal to 40, 58, 70 and 85 per cent of the full impressed line voltage, and respective currents approximately equal to 16, 34, 50 and 72 per cent of the current that would be taken by the motor if it were started directly from the supply line.

In Fig. 54, an outline diagram shows the connections of a two-phase motor connected to a two phase four wire power supply through the intermediary of an auto-transformer or compensator. The transformer acting resist-

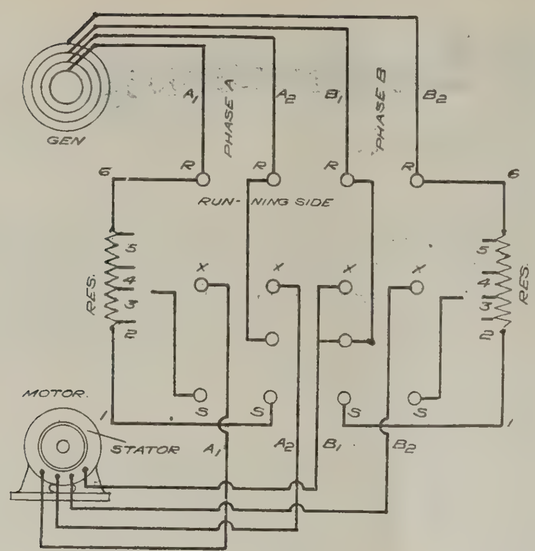


FIG. 54. DIAGRAM OF CONNECTIONS FOR A TWO-PHASE MOTOR AND AUTO-TRANSFORMER.

ances, one in each phase, are shown with voltage taps 2, 3 4 and 5. The motor connections are shown connected to transformer voltage tap number three. A double throw four pole knife break switch, the heel of the blades of which are pivoted at the terminals marked (X), is thrown over into the contacts S, S, S, S, at starting. This puts the compensator windings in circuit with the motor stator; and the motor terminals should be connected to such a voltage tap that the motor runs up to full speed within one minute after the switch is thrown into the starting circuit. After this the switch is quickly thrown over to the running contacts R, R, R, R, in which position the compensator resistances are entirely cut out of circuit, the motor being then connected directly to the supply lines, is practically short circuited and receives full line impressed voltage.

In Fig. 55, the connections of a two phase motor are shown connected to a two phase four wire power supply with a compensator, which effects a change in the connections of the coils of the stator from series at starting, to parallel at running.

Fig. 56 illustrates a three phase motor connected to a three phase power supply, with a special starting compensator that effects a change in the connection of the

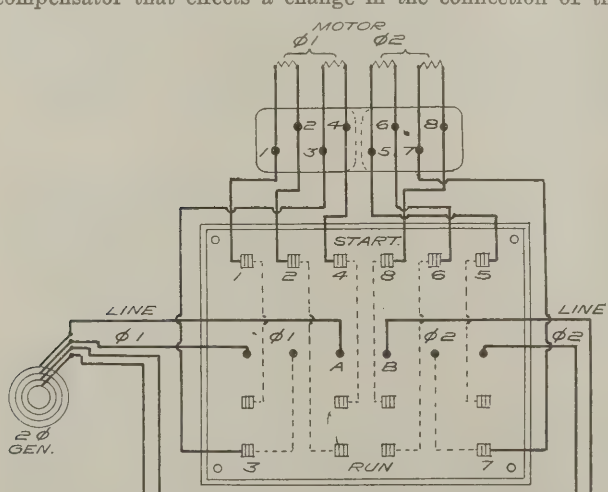


FIG. 55. CONNECTIONS OF SAME APPARATUS AS IN FIG. 54, COILS OF STATOR IN SERIES AT STARTING, IN PARALLEL AT RUNNING.

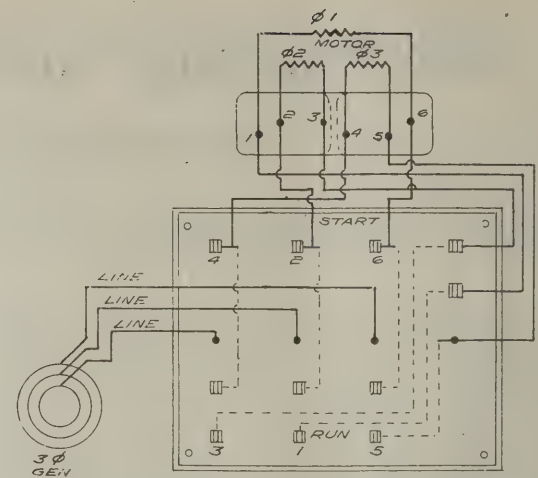


FIG. 56. DIAGRAM OF CONNECTIONS FOR A THREE-PHASE MOTOR, STATOR WINDINGS Y AT START AND DELTA AT RUNNING.

stator winding from Y (star) connection at starting, to Δ (delta) connections when running. The star connection is practically equivalent to throwing the coils in series, and the delta to throwing them in parallel or multiple.

To reverse the direction of rotation of the rotor, interchange any pair of the three phase line leads. In the case of a two phase motor, interchange two leads coming from the line to either phase. With a two phase, three wire system of supply, the terminals marked AB in Fig. 55 and located on the back of the switch, should be metallically connected together and to the middle wire of the three phase supply. Fig. 57 illustrates a three phase motor and three phase compensator, connected to a three-phase power supply. It will be seen that the switch blades 2, 4 and 6 are in the main line circuit, and 1, 3 and 5 are connected to the motor. In this diagram of connections there is no provision made for fuses, overload cut-outs etc.

There are compensators in which the lever controlling the switching device comes to rest in three positions, an off, starting, and running position. In the off position the compensator windings and motor are entirely disconnected from the supply lines. In the starting position, the switch connects the power lines to the terminals connected to the ends of the compensator windings, without any automatic breaks or fuses in circuit. In Fig. 58 there are two auto-transformers, the two separate phase lines being connected to the ends of the separate auto-transformer windings, while during the starting period the motor is

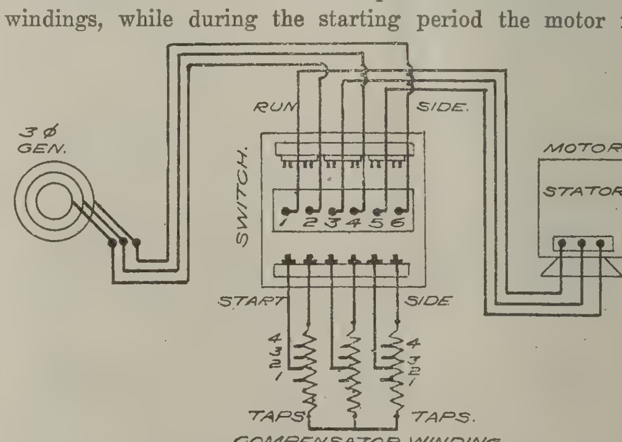


FIG. 57. CONNECTIONS FOR THREE-PHASE MOTOR AND THREE-PHASE COMPENSATOR.

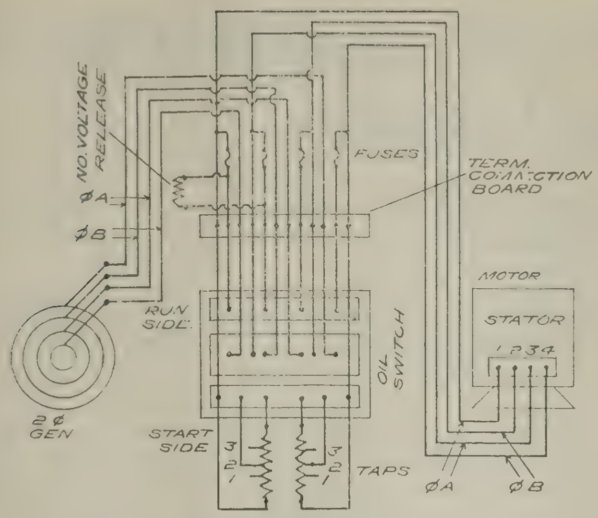


FIG. 58. TWO-PHASE MOTOR AND COMPENSATOR CONNECTED TO TWO-PHASE POWER SUPPLY.

connected between two of the ends and two intermediate taps. In the running position the compensator winding is entirely disconnected from the main line circuit. The motor then is connected directly to the supply power lines, in the circuit of which is inserted suitable fuses or overload cut-out or relay switches, mounted conveniently near the compensator.

The necessary circuit combinations are effected by a suitable switching device, controlled by the starting lever. It will be seen that provision is made for two leads in each phase on the compensator terminal connection board. The object of this is to allow the resulting large starting currents to pass the fuses, thus preventing them from cutting out, the circuit being so arranged that when switched on to the running position, the fuses and automatic devices are then in circuit. When running, the provision of cutting the compensator windings entirely out of circuit, prevents overheating and needless waste of energy in the form of iron and copper losses.

In Fig. 58 is illustrated a two phase motor and compensator connected to a two phase power circuit with fuses and a no-voltage release, which acts automatically. The object of this is to release the compensator lever, allowing it to fly back to the off position when the voltage of the supply is at minimum. A two phase motor and compensa-

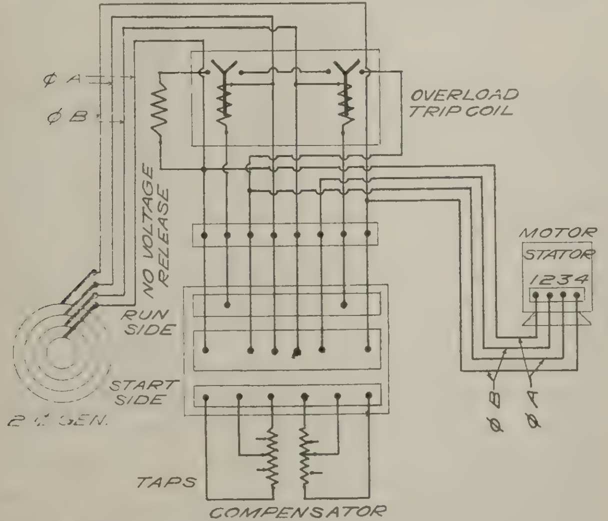


FIG. 59. TWO-PHASE MOTOR AND COMPENSATOR WITH NO-VOLTAGE RELEASE AND OVERLOAD TRIP COIL.

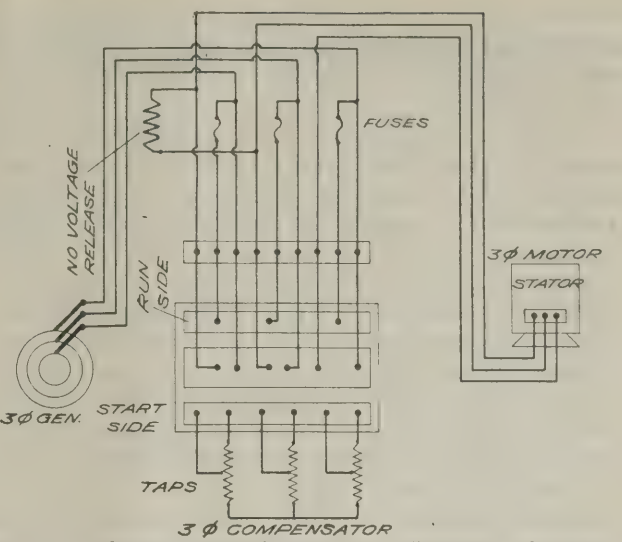


FIG. 60. THREE-PHASE MOTOR AND STARTING COMPENSATOR WITH FUSES AND NO-VOLTAGE RELEASE.

tor with no voltage release and overload trip coil connected to a two phase circuit is illustrated in Fig. 59. The object of the trip coil is to automatically open or break the circuit when an excessive overload current flows, thereby causing the no voltage relay to release the switch. The overload trip coil relay can be adjusted to act at various current capacities. Fig. 60 illustrates the diagram of connections of a three phase motor and starting compensator with fuses and no voltage release connected to a three phase power circuit. Fig. 61 is the same, excepting that overload relay trip coils are used instead of fuses.

In Figs. 58 and 60 the compensators are shown as furnished with no-voltage relays. In this type the compensator cannot be thrown into the running position without first returning to the starting position, the action of the no voltage release on the compensator switch automatically providing for this. The fuses are for overload protection and the no voltage release automatically acts when the voltage fails.

Sometimes fuses are objectionable, and overload series trip coils are then utilized. These relays are so arranged that when an overload occurs, they automatically open the no voltage relay circuit, which in turn releases the switch. This compensator arrangement is shown in Figs. 59 and 61. The relay, if properly adjusted, has the advantage of

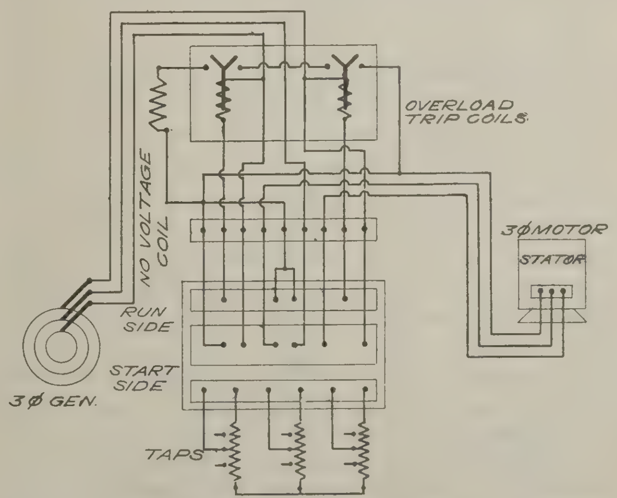


FIG 61. THREE-PHASE MOTOR AND STARTING COMPENSATOR WITH NO-VOLTAGE AND OVERLOAD AUTOMATIC CUTOUT.

protecting the motor against running single phase, due to the fact that any increase in load caused by the motor running single phase results in an increased current sufficient to automatically trip the relay.

Fig. 62 is an illustration of a three phase motor connected to a three phase power supply and starting compensator with no voltage and overload cut out relay, with transformer for voltages of 1,040 to 2,500. When compensators are used on circuits of so high a voltage as 1,040 to 2,500 and furnished with a no-voltage relay, the relay is wound for 110 volts. This necessitates that it be connected to some low tension circuit, which would be affected in case of the failure of the motor voltage, or if such low tension circuit is not available. Provision is made to attain this desirable condition by the alternative arrangement of connecting through a small transformer to the motor leads, as shown in Fig. 62.

Compensators to be used with induction motors wound for 110 to 550 volts, should be provided with fuses of the cartridge type, mounted on a slate base and separated by barriers; while for motors wound for 1,040 to 2,500 volts, the compensator should be provided with the expulsion type of fuse. Fuses are usually supplied of a capacity or fusing current of one and a quarter times the full load current of the motor. Fig. 63 illustrates the connections of a three phase motor on a three phase power supply and starting compensator with separate switches for motors of large size and high voltage. Starting compensators may be wound and are practically utilized for any voltage and current for which it is practicable to build motors.

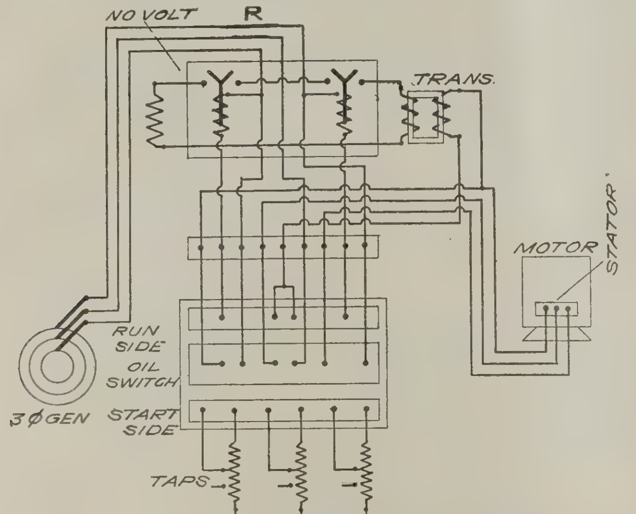


Fig. 62. Three-Phase Generator and Motor with Starting Compensator, No-Voltage Release and Overload Cutout Release.

For motors with high voltages or large current capacity, the switching device is separate from the compensator itself and consists of triple and four pole switches for three phase and two phase motors respectively. One double throw or two interlocked single throw switches are required for the motor, and a single throw switch for energising the compensator. The running side of the motor circuit is provided with fuses or automatic circuit breakers, that is, trip coil relays, as shown in Fig. 63. The compensator arrangements, as shown in Figs. 58 to 62, are practically utilized for motors up to and including 550 volts when the normal current does not exceed 300 amperes per phase; and for motors from 1,040 to 2,500 volts and a current not exceeding 125 amperes per phase. For motors

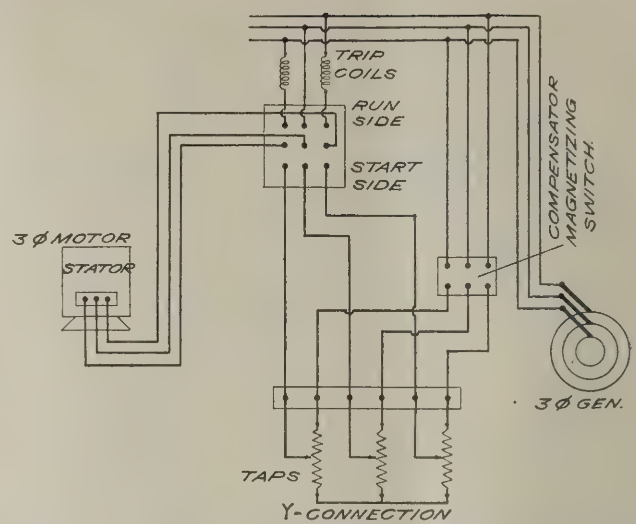


Fig. 63. Three-Phase Motor with Starting Compensator with Separate Switches for Motors of Large Size and High Voltage.

of higher voltage or larger current capacities the arrangement as outlined in Fig. 63 is utilized. In the three phase compensator arrangement as shown in Fig. 60, the three coils of the three phase compensator windings are connected in Y (star), the lines to the three free ends of the coil and the starting connections of the motor to the taps, while in the two phase compensator, the line is connected to the ends of each compensator coil and the starting connections of the motor to one of the ends and the taps.

Annual Meeting of New England N. E. L. A.

The annual meeting and convention of the New England section of the National Electric Light Association will be held at Hotel Kimball, Springfield, Mass., March 14 and 15, 1912. Five very interesting papers will be presented and discussed at this convention, the titles being as follows: "The Use of the Electric Vehicle in New England;" "Report of the Rate Committee;" "Load Factor and Power Factor—How to Improve Them;" "Exhaust Steam Turbine Applied to Electric Lighting;" "Discussion—Should the Central Station Maintain a Wiring Department?"

Nature and Use of Tungsten.

The mineral tungsten, the name meaning heavy stone, has been known for many years, but only comparatively recently has it become of economic importance. The most important use, according to Frank L. Hess, of the United States Geological Survey, and the one which makes tungsten mining on an extensive scale possible, is as an alloy for tool steel. Lathes using tools made from tungsten steel may be speeded up until the chips leaving the tool are so hot that they turn blue, an operation which would ruin the temper of high-carbon steel. It is stated that about five times as much can be done with lathes built for such speed and work as can be done by the same lathes with carbon-steel tools. From 16 to 20 per cent of tungsten is ordinarily used in lathe tools. The melting point of tungsten is exceedingly high—5,576 degrees F.

Tungsten also has an important use in making incandescent lamps, crucibles for electric furnaces, and various other articles.

Cost Data on Power Plant Installation and Operation.

(Data Taken From the Experience of a Consulting Engineer and a Master Mechanic.)

Abstract of Data from the Engineering Magazine on Steam Plants. Also a Discussion on Steam and Electric Plants for Textile Mills.

COST data on engineering work is always valuable to those in the constructing and operating field, especially when such data is presented in a manner that will lend itself to careful analysis and comparison. In what follows we are presenting through the courtesy of the *Engineering Magazine,* an abstract of a very valuable article under the above title, prepared by W. H. Weston, a consulting engineer of extensive experience, and also the main features of a discussion by S. B. Rhea, master mechanic of the Monaghan Mills, of Greenville, S. C., as delivered before the Southern Textile Association.

In Mr. Weston's article he treats only briefly cost data of water-power plants devoting the major part of the material to steam plants. He places the general cost averages of electric light and power stations at from $2.75 to $3.00 per square foot of floor area, the first figure being for water power plant buildings exclusive of extensive foundations required for particular cases. Waterworks pumping stations average, in plain construction, about $3.00 per square foot of floor space.

The cost per horsepower for waterpower plants is placed at from $50 to $500, with the majority of plants costing not more than $150 per horsepower. The author clearly points out that the cost of water power plants is far more than steam plants based on the same capacity. In comparing water with steam plants he gives interest on the former as 5 per cent., the taxes and insurance at about one per cent., depreciation two per cent., repairs at one per cent., making a total of nine per cent. for water power against 13 per cent. for the same items as given for a steam plant. With the first cost of steam plant less than for water plant, the saving through the latter in coal and wages of attendants is often counterbalanced.

The tables of costs for steam plants given by Mr. Weston are very interesting and we present a few of them together with other comments in what follows.—EDITOR.

AVERAGE COST, COMPOUND-CONDENSING STEAM PLANTS.

Horsepower	Cost
*100	$ 10,000
*200	19,000
*300	25,500
*400	31,000
500	38,000
600	45,500
800	56,500
1,000	66,500
1,500	95,000
2.000	121,000
4,000	225,000

*No economizers.

Allowance is made for reserve boilers, 33 per cent extra on 600 horsepower to 12 per cent extra on 4,000 horsepower.

Taking up now the mechanical equipment of steam plants, the first table shows the average cost of compound-condensing steam plants, not including mechanical stokers, or ash- or coal-handling equipments. The figures include engine and boiler houses, engine foundations, condenser and pump foundations, chimney, boilers (including settings and fittings), economizers (except where noted), all piping, valves, feed pumps, heaters and separators; engines, condensers, air and circulating pumps. And from one to two dollars per horsepower for miscellaneous costs.

For 1,000 horsepower or more, ash-handling plants cost $0.50 to $3.00 per horsepower, and coal-handling plants $1.00 to $6.00 per horsepower.

AVERAGE COST OF ENGINES, CONDENSERS, AIR AND CIRCULATING PUMPS

Horsepower	Cost
400	$ 9,500
500	11,500
600	13,500
800	18,000
1,000	22,000
1,500	32,000
2,000	42,000
4,000	80,000

AVERAGE COST OF STEAM AND WATER PIPING, VALVES AND SEPARATORS.

(Compound condensing plants)

Horsepower	Cost
400	$ 3,600
500	4,000
600	4,500
800	5,200
1,000	6,200
1,500	9,000
2,000	11,000
4,000	20,000

AVERAGE COST OF CERTAIN AUXILIARIES IN COMPOUND-CONDENSING PLANTS.

Horsepower of Plant	Feed Pumps Cost	Heaters Cost
400	$160	$ 800
500	175	875
600	190	900
800	220	1,000
1,000	250	1,100
1,500	325	1,400
2,000	380	1,800
4,000	700	3,000

COST OF DUPLICATE INDUCED MECHANICAL-DRAFT EQUIPMENT

For 500 horsepower or more the average cost of economizers, including settings and scraping equipment, is $4.00 per horsepower, the horsepower being figured on compound-condensing basis.

AVERAGE COST OF WATER-TUBE BOILERS.

Including setting and fittings, but no mechanical stokers or economizers.

(Horsepower figured on compound-condensing basis.)

Horsepower	Cost
400	$ 5,500
600	7,500
800	9,500
1,000	11,500
1,500	15,500
2,000	20,000
4,000	38,000

The average cost of inside-firebox boilers of 200 horsepower or more is 12 to 14 cents per pound f.o.b. boiler shop (not including boilers of exceptional construction.)

AVERAGE COST OF BUILDING CONSTRUCTION IN COMPOUND-CONDENSING PLANTS.

Horse Power of Plant	Engine and Boiler Houses	Foundations for Engines, Condensers and Pumps
400	$ 7,000	$ 1,400
500	7,500	1,800
600	7,800	2,200
800	8,500	2,800
1,000	9,500	3,400
1,500	13,500	4,800
2,000	17,000	6,000
4,000	30,000	10,000

On an average, stationary compound-condensing engines of 1,000 horsepower use 17 pounds of water per horsepower hour with steam pressures of 125 to 135 pounds, engines of 2,000 horsepower about 15 pounds, and engines of 4,000 horsepower about 14 pounds. From a summary of a large amount of data in which a large variety of soft coals were used, the following figures are obtained. With boilers working to a fair maximum performance, without overcrowding, and with an average chimney draft of 0.43 inches, the average coal per square foot of grate per hour is 19 pounds; average water evaporated per pound of coal, 8.65 pounds. This is under ordinary running conditions, feed at an average temperature of 190 degrees F., flue gases 450 degrees to 550 degrees, chimney draft 0.43 inch.

$17/8.65 = 1.96$ lb. coal per horsepower hour.

$19/1.96 = 9.7$ horsepower per sq. ft. of grate.

$15/8.65 = 1.73$ lb. coal per horsepower hour.

$19/1.73 = 11$ horsepower per sq. ft. of grate.

$14/8.65 = 1.62$ lb. coal per horsepower hour.

$19/1.62 = 11.7$ horse power per sq. ft. of grate.

In figuring out the quantity of water required per horsepower hour for a given plant, it must be remembered that, for instance, four 1,000 horsepower engines will not run on as small an amount of water as one 4,000 horsepower engine. In regard to the figures for the cost of boilers, the ratio of grate area to heating surface is assumed as coming between the usual figures in boiler construction, so that the amount of coal burned per square foot of heating surface will average 0.4 to 0.45 pounds per hour, or not over 0.5 pounds as an extreme.

Probably the amount for the best all-round efficiency is about 0.42 pound. The average amount of water evaporated per square foot of heating surface per hour in water-tube boilers is about 4.2 pounds; in tubular boilers, about 3.5 pounds. For the total amount of coal required for a plant, the given figures 1.96, 1.73 and 1.62 pounds per horsepower hour must be increased about 15 per cent to allow for keeping fires over night, steam used by auxiliaries, condensation in pipes, radiation, etc., which makes them 2.25, 2.00 and 1.86 pounds respectively. Any steam used for heating or other purposes will be extra.

Compound-condensing engines of 800 horsepower average about 18 pounds of water per horsepower hour, and $18 \div 8.65 = 2.08$ pounds of coal per horsepower hour; adding 15 per cent we get 2.39 pounds per horsepower hour total. Engines of 600 horsepower use about 19 pounds, engines of 400 horsepower about 20 pounds of water per horsepower hour. The average cost of oil, waste and small supplies for a compound-condensing steam plant in dollars per year $= 12 \sqrt{\text{h. p.}}$

The average cost per year for labor (no repair labor) on a compound-condensing steam plant at the present time, running 10 hours per day, is as follows:

LABOR COST, COMPOUND-CONDENSING STEAM PLANT.

Horsepower	Cost per Year
400	$ 2,400
500	3,000
600	3,400
800	4,000
1,000	4,500
1,500*	4,600
2,000*	5,600
4,000*	9,000

*Mechanical stokers, ash- and coal-handling plants installed.

Interest, insurance, taxes and depreciation in most compound-condensing plants will be 10 to 11 per cent. Average depreciation on engine plants is 4 per cent.; and on boiler plants is 5 per cent. Cost of repairs usually ranges between 2 and 3 per cent., according to what the plant was when new, how much load is put onto it, and how it is handled, whether repairs are made as needed, and whether they are properly and effectively made. Producer-gas power plants cost on an average from 30 to 50 per cent. more than steam plants of equal power, this extra cost being counterbalanced by the reduction in the amount of coal used per horsepower in the operation of the plant equipped with producers.

The cost of labor is about equal in the two plants. The talk about its requiring higher skilled labor for the gas plant has no foundation, except probably that there have not been so many engineers thoroughly familiar with gas plants, and consequently it has been harder to get good men, as far as it can be summarized, it appears that costs of repairs are about equal in the two plants, but deterioration will be greatest in the gas plant.

Features of Power Plant Costs for a Textile Mill.

In connection with the above general data taken from the *Engineering Magazine,* we present information of the same general nature referring particularly to operation under certain conditions, namely those of a textile mill. The case considered is a 55,000 spindle cotton mill, giving detailed costs for a modern steam plant and for a mill electrically equipped. The costs include appliances for the steam plant, engines, 32 and 64 x 60 inches, cross compound condensing complete, foundations, condenser, all necessary pumps, all piping, boilers, stack or chimney or induced draft, engine room building, also drive to main line shaft, and add to this the installation of the same. And also on

the electric side to consider all costs, price of motors, switchboards and all material, and also the cost of installation.

STEAM PLANT—COST OF INSTALLATION.

We quote S. B. Rhea already referred to, in what follows: I have here a proposition in the way of a letter from a well-known engine builder who will build and erect on purchaser's foundation, together with modern water tube boilers, all pumps, including condenser, and all necessary boiler feed pumps; this equipment to consist of a 32 and 64x60-inch cross compound condensing engine with an initial steam pressure of 155 or 160 pounds, running 80 or 85 R. P. M., and jet condenser, all connected and ready to run, for $85,000; and the rated power of the machine is 2,500 horsepower, being a rate of $34 per horsepower.

I have here blue prints showing the foundation of an engine of this size—32 and 64x60 inches, for running at 80 or 85 R. P. M., and also will add that there are several engines of this size running on this very same foundation's plane in the Carolinas. This foundation stands 13 feet above the level of the ground, one foot of concrete footing covering 42x46 feet. I had an estimate made by a contractor of this kind of work and who does a $100,000 business annually. I have a letter from him giving his estimate at $3,165.50, or at the rate of $1.26 per horsepower; this includes foundation for engine and condenser. In this lay-out I will estimate an exhaust fan. I have information from a manufacturer, where a fan of ample size for boilers of this capacity would cost $1,260, including automatic regulating valve and installation, etc., or at the rate of fifty cents per horsepower.

It seems to be a question among operating engineers as to which they prefer, high chimney, or exhaust fan and economizers, but there seems to be no question among the mechanical engineers as to the installation of a fan. It is claimed by engineers that a good mechanical draft will give better and smokeless combustion from any kind of fuel, or cut the cost of fuel by utilizing a cheaper grade of coal. With plenty of draft under control, it is possible to burn soft or hard coal slack or the cheaper Western coal. With proper furnaces and mechanical draft, this may be done with high boiler efficiency and with little smoke.

One horizontal smoke connection 90 feet long, 9x9 feet at the large end, having uptakes 18x48 inches, with dampers all erected, would cost $1,350. A smoke stack 45 feet high, 7 feet diameter of 3-16 steel with suitable band guys, etc., erected, would cost $525. This makes $1,875, or 71 cents per horsepower.

To build a chimney 175 feet high and 9 feet inside would cost $7,500, or $3 per horsepower. Besides this, the engine room building 44x70 feet, 13-foot basement and 22-foot story in engine room, cost including gravel roof, trusses and boiler room 44x115 feet, everything complete, would cost $2,465, or in round numbers, $1 per horsepower.

Among other things you will have to have plenty of cool water for condensing purposes. There are two ways of getting this: One way is by having a large body of water and handling it every three or four days, giving it ample time to cool. And the other way is by the cooling tower, and using a small amount of water, just taking the minimum of water used for fire protection. On inquiring into the cost of a reservoir, I find that it is always fixed by surroundings. I find in most places they have natural conditions and the cost runs down as low at 25 cents per horsepower. The writer knows one of the large mills in South Carolina that is situated in one of the leading towns, where the reservoir cost was as low as 10 cents per horsepower and others that are situated on watercourses that cost merely nothing.

In using the cooling tower, you would want, for a 32 and 64x60-inch engine, say 37,500 pounds of steam, 26-inch vacuum, 75 degrees atmospheric temperature, and 70 degrees relative humidity, a tower that would cost when complete about $9,000. Such a tower has four 120-inch fans, each pair of fans requiring 24-horsepower, or a total of 48 horsepower, and this horsepower at 12 cents per horsepower would increase the operating expense 23 cents per horsepower.

Now, in comparing the tower with the reservoir, I would prefer a reservoir up to this cost of tower, and if found that the water supply and natural conditions were such that you could not build a reservoir I would install a cooling tower at the cost of $3.60 per horsepower.

ECONOMIZERS.

Economizers are not necessary. I mean that in building a steam plant it can be built without the economizer, and they are put in only for the simple reason—to reduce coal consumption and possibly increase boiler capacity also. The builders claim and guarantee, I think, a saving of 10 to 20 per cent. by their installation. And if it were for comparison against any other prime mover, the amount taken to complete the installation should not be accounted for unless the saving was taken into consideration.

But, at any rate, we will consider the cost. Economizers with 700 pipes would cost approximately $9,800, or $3.92 per horsepower for a 2,500-horsepower engine. For an engine of this type and size, with proper rope wheel and with jet condenser and all piping between the condenser head and hot well the engine being delivered and erected on purchaser foundation at competitive point in the Carolinas, would cost $13.67 per horsepower. The piping for condensing would cost $3.70 and the steam pipe to the boiler room could be installed for ninety cents per horsepower.

To summarize the cost of installation, per horsepower, we have:

Engine and condenser	$13.67
Piping, etc.	3.70
Fire tube boilers	5.00
Installing fire tube boiler	1.82
Fan and stack	1.21
Foundation	1.26
Boiler pumps	.25
Economizer	3.92
Drive	1.00
Pipe in to boiler	.90
Pipe covering	.50
	$33.23

GROUP MOTOR DRIVE.

We will now consider a motor drive on a basis of 2,300 volts, 60 cycle, 3-phase induction motors for ceiling suspension for a 55,000-spindle mill.

The motors would be divided as follows: 10 motors of 150 horsepower; 8 motors of 100 horsepower, and 5 motors of 50 horsepower. This gives a total of 2,500 horsepower. For this is needed one incoming line panel, three feeder panels, and 23 oil switches for wall mountings, one for each high voltage motor. The total cost of this appara-

tus delivered in Charlotte is $28,687, or $11.25 per horsepower. These figures do not include installation or wiring and possibly it can be done for $2.60 per horsepower, making the total cost per horsepower equal $13.85.

INDIVIDUAL DRIVE.

In the individual drive we would have 220 motors for the 220 spinning frames, 250 spindles to the frame, which would give the mill 55,000 spindles; and the average spinning frame takes five horsepower; this will give us 1,100 horsepower of 281 kilowatts. All these motors are small. They can not, of course, operate on high voltage and we are compelled to figure on 220 or 110 volt machines.

This 1,100 horsepower will require 821 kilowatt to be stepped down from 2,300 volts to low voltage. Therefore, we need 220 five-horsepower motors and 821-kilowatt in transformers, and with a small switch mounted on a slab for starting purposes. The total will cost in Charlotte, $18,535 or $16.85 per horsepower.

In addition to this, we have left 1,455 horsepower for the pickers, cards and weaving. Figuring this end of mill then at the price as covered by the case of group drive at $11.25 per horsepower, this will be $1n,367. This amount added to $18,535 for the spinning room gives $34,902. The wire and installation cost $7,650. This gives $16.70 per horsepower.

To summarize, we have the steam plant installation to cost $33.23 per horsepower. Group electric drive costs $13,85 per horsepower, and individual electric drive costs $16.70 per horsepower.

Some Important Features of Patents.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY MAX ZABEL.

IN a recent issue, peculiarities of patent law in its bearing to the present automobile situation were taken up. Another interesting patent situation somewhat similar was due to the highly litigated Berliner patent. When Prof. Alexander Graham Bell's original telephone patent expired, the Bell Telephone company naturally sought to retain this monopoly and depended for its maintenance on the Berliner patent which had also lain in the Patent Office for sixteen years before it had issued, and was thus available when Prof. Bell's patent expired. In the course of the litigation it was brought out that no fraud existed during the prosecution of this patent for sixteen years in its course through the Patent Office, but the patent was decided invalid because of its want of novelty. This of course left the telephone field without any controlling patent.

At about the same time the Carty patent which also related to telephony was declared void. This patent aimed to cover the operation of a plurality of telephones on one line for party line service and the means employed consisted of using highly wound 1,600 ohm ringers bridged across the line for each telephone. If this patent had been sustained, it would of course have covered all of the farm lines and probably all of the city party line telephones, but as it was held invalid its influence on the telephone industry was slight. This patent was not declared invalid by being anticipated, strictly speaking, but was declared invalid because the change from the prior art to provide the Carty bridging bell system was a matter of mere mechanical skill which did not rise to the dignity of invention. Similarly it is not invention to produce an article which differs from some old thing only in excellence of workmanship.

Likewise it is not invention to substitute superior for inferior material as a general rule. There are important exceptions to this however. If the result obtained in entirely new, of course, such substitution is invention, likewise if the mode of construction is thereby changed, the substitution amounts to invention. It might also be said that such substitution is invention when it results in a new function or a new mode of operation, or which is of more importance if it serves to provide the first practical success in the art to which it belongs. It might also be said that when more efficient action results, the substitution may amount to invention. Generally speaking it does not involve invention except under the conditions just mentioned to enlarge and strengthen a machine so that it operates on larger material. Ordinarily to change the degree of a thing may not be invention, yet such change in degree may amount to invention as for instance in the case of the Edison incandescent light patent.

The Edison patent differs from the Sawyer and Mann patents only in that the diameter of Edison's film had a diameter of one sixty-fourth of an inch or less, whereas the burners of Sawyer and Mann had a diameter of one thirty-second of an inch or more. It might be said however, that in this case, new results were obtained and consequently this change of size was held to be invention. For instance, by reducing the diameter one-half, the resistance was increased fourfold and the radiating surface was reduced two fould, whereby the ratio of resistance to the radiating surface was increased eightfold. Consequently the resistance could be made eight times as large without increasing the loss of energy in the transmission line, or the transmitting conductor might be reduced to one-eighth the amount of copper. The change also was the first to secure a system in which higher voltages, in this case one hundred and ten volts, could be used. This voltage was practicable whereas the previous voltages on account of the size of copper required in the conductors were entirely impracticable.

This further will emphasize that the procuring of a new result is the essential feature irrespective of the actual means employed in producing the result. It must of course be borne in mind that the result secured must be patentable and the means shown to procure the result must be practicable.

Electric Light and Power Plants in Western Japan.

The number of electric light and power companies is increasing rapidly, new ones being organized in all parts of Kyushu. Most of the companies that first entered the field were quite successful, especially the hydroelectric, and dividends of 10 per cent and more are being distributed, so the rush is on with vigor to secure water-power rights on the streams, and the promoters are busy with the prospectus of their prospective schemes, many of which are really good.

For some years past it has been reported that a large company would be formed to utilize the water powers of the island of Kyushu on a big scale, and this plan seems to have been realixed on April 5, 1911, when the Kyushu Hydroelectric Co. was organized in Tokyo with a capital stock said to be $4,000,000. The scheme is to develop electric properties, buy rights already granted over river courses and acquire new ones, make investigations and surveys of the different streams, and do a general electric business.

The Storage Battery in Telephone Exchanges.

BY H. H. WILLIAMSON.

At the convention of telephone district superintendents, held at Halifax, Nova Scotia, some time ago, which brought together a large number of men of wide experience in telephone work, a paper of considerable interest, taking up the subject of the storage battery in telephone exchanges, was presented and we publish it as follows:

Probably no piece of apparatus in the modern telephone exchange plays a more important part and is so little understood as the storage battery. No doubt it is chiefly the storage battery that has made central energy telephone operation a commercial and electrical success, and this is due to certain characteristics possessed by it that are not found in other types of cells. The most important are low internal resistance, high voltage, large output, low maintenance (charging cost excepted) and long life.

Since the entire exchange depends directly upon the storage battery for its power and energy, it is very essential that this piece of apparatus should receive special care and attention in order to maintain the highest degree of working efficiency. The reason that so little is known concerning the storage battery by the average telephone man is probably due to the fact that the internal reactions are more of a chemical than an electrical nature. While the complete chemical analysis of the storage battery is quite complex, the general theory is very simple, and anyone having them under his care and management should, at least, have a superficial understanding of the performance of the battery during charge and discharge other than the mere changes of gravity.

When a battery is charged it does not mean that any electrical energy as such has been given to the plates, or resides in them, but simply that the electric current has brought about a change in the chemical condition of the plates such that they form an active voltaic couple or battery, and in their general behavior differ in no wise from any primary cell.

GENERAL THEORY OF THE STORAGE BATTERY.

Any voltaic couple that is reversible, that is capable of regeneration after exhaustion by passing an electric current through it in a direction opposite to that of flow on discharge, is a storage battery or accumulator.

A storage battery consists essentially of two elements, the positive and negative plates, and the electrolyte. The elements are lead plates, known as the grids, composed of lead with a small per cent. of antimony to give them strength and hardness, and these plates are cast with circular holes in them to receive the active material. This active material is what undergoes the chemical change due to the action of the current, the plate or grid being a supporting and conducting element only. The active material is peroxide of lead on the positive and sponge lead on the negative plate. Sponge lead is a porous form of pure lead which has probably undergone some physical rather than a chemical change. The active material is forced into the holes in the plates under a high pressure, and should have good electrical and mechanical contact with the plates in order to produce an efficient and durable cell. When these plates are immersed in a dilute solution of sulphuric acid and water of a specific gravity of 1.21 more commonly called 1210, we will have a fully charged storage battery. If the positive and negative plates are now joined by some external conducting circuit a current will flow and in discharging will produce the following chemical actions: The current decomposes the sulphuric acid and liberates sulphur trioxide gas known by the chemical symbol of SO_3. This SO_3 unites with the lead peroxide on the positive and the sponge lead on the negative, turning these two elements into lead sulphate. The change of lead peroxide and sponge lead to lead sulphate causes an expansion of the active material, and if the cell is discharged too rapidly or too low there is danger of breaking or bending the plate. It is probably this increase in the volume of the active material that produces most of the buckling of battery plates. As the SO_3 or sulphur trioxide is liberated from the electrolyte on discharge, water is formed, and, as this action decreases the density of the solution, the hydrometer gradually falls. When a charging current is sent through the cell in an opposite direction, the reverse chemical action takes place.

The lead sulphate on the positive and negative plates gives up the SO_3 back to the electrolyte, forming sulphuric acid with the water, increasing the density of the solution, which causes the hydrometer to rise. When the active material gives back all the SO_3 to the electrolyte we have a fully charged cell with lead peroxide and sponge lead on the plates.

Briefly, then, a fully charged battery is one in which the active material is sponge lead on the negative and peroxide of lead on the positive plates, and a discharged cell has these two elements changed to lead sulphate on both plates.

Lead sulphate is white, possesses a high resistance, and is in fact an insulator, and if the cell is discharged too fast the lead sulphate formed may increase the internal resistance materially.

When a cell is not discharged below the gravity limit, the lead peroxide is not all converted to lead sulphate; a sufficient quantity remains to keep down the resistance. As the internal resistance of a large storage cell is infinitely small, it is important that over-sulphating be prevented. There are many other intermediate reactions and by-products of decomposition, but they belong more strictly to the chemistry of the storage battery, and are therefore beyond the scope of this paper.

CARE OF THE BATTERY.

The life of a storage battery greatly depends upon care and the attention it receives, and many a battery has been ruined by careless and improper treatment.

A battery should never be charged or discharged above the normal rate, and even charging at too low a rate is sometimes considered injurious. The specific gravity of a cell when fully charged should preferably be 1210, but it may vary considerably below this without materially affecting the capacity of the cell. Acid should never be added to a cell until it is positively known that the low specific gravity is due to lack of acid and not to insufficient charging. It is not the usual custom to add acid to a cell unless the gravity on overcharge is down to 1190, but from experience I would say that any cell that shows a gravity below 1195 on full charge requires acid. If it becomes necessary to increase the gravity of a cell, acid of about 1210 should be used and added to the cell before starting a charge, in order that it will thoroughly diffuse and mix with the electrolyte during the charge. Distilled water should always be introduced into the cell at the bottom, and this can be accomplished by using a glass funnel and glass or rubber tube. Water poured on at the top, by reason of its lower density, will float and hardly mix at all.

I will say very little regarding the daily charge of the battery, for I think that each exchange is furnished with printed instructions which, if followed closely, will give satisfactory results. The overcharge should not be continued too long, for the reason that, when a cell shows no further rise in gravity for five successive fifteen minute readings (charging at normal rate), it is considered fully charged, and any continuation of the charging current is a loss and causes deterioration of the plates. On overcharge the temperature rises and should it approach 100 degrees Fahrenheit, the charge should immediately be stopped and the cell allowed to cool. High temperatures are more harmful than low ones.

The battery reports are an important item in the management of storage batteries. As it is necessary to refer to the yearly books and reports of any large commercial or mercantile business in order to know its financial standing, so are the battery reports the only records we have for determining the condition of the batteries and the care they have received during service. The printed instructions on the battery report should be followed as nearly as possible, and above all the report should be filled out completely.

There is one question that is often asked concerning storage batteries, that is: Why is one side of the battery grounded? In the first place, since it is impossible to keep a system entirely free from ground, it is found better to ground permanently one side of the battery, and a line ground coming on the opposite side of the battery will at once show itself by signalling the central office. Another and more important reason is to keep the potential or voltage of the entire system as near the earth potential as possible. For supposing that a telephone system was practically free from all grounds both in the central office and on the lines, and a high voltage power or other circuit became crossed with one of the telephone wires at some point, the entire system would be charged with this high voltage, thus endangering the lives of both workmen and the general public. By grounding one side of the battery, the potential of the system is only 24 volts above the earth potential.

Averaging Bristol Charts With a Planimeter.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)

BY CHAS. E. BECKWITH.

IN some cases the Bristol recording wattmeter is used in charging for power at the peak load or maximum demand basis. In most instances, however, this instrument, as well as the various other recording meters of this type, including recording voltmeters, ammeters, pressure gages, etc., are used for the purpose of having a visible record and a check on the load or pressure for each and every hour.

In case of tests or computing the cost of power per kilowatt hour in a power house equipped with these meters and in numerous other instances, it is necessary to obtain the average of the record on these charts. While there is an instrument on the market for this purpose, it is not always convenient or possible to obtain one. Very few engineers of today are without a planimeter, however, and in case it is necessary to buy one, it has many other uses.

To average a chart with a planimeter, set the planimeter acording to directions furnished with that particular instrument for measuring areas. The first thing to do next is to compile a table of areas and pounds pressure, kilowatts or volts or amperes, as the case may be, for the particular chart. This may be a somewhat tedious job, but when once the table is made up, it is good for that number chart permanently.

As an illustration of the method to use, take the No. 364 Bristol kilowatt A. C. chart, a table of which is given below. First set up the planimeter the same as if going to measure the area of an indicator card. Trace the zero line first, getting the area contained inside of its circle, then each 10 K.W. line up to 150 K.W. Above the 150 K. W. line is above the limit of the planimeter used. From this point up the chart was divided exactly in halves, tracing only one half and doubling the result for the total area. In tracing the half, always be sure to cross the base line or the reading will not be correct.

AREA AND K.W. TABLE FOR BRISTOL K.W. CHART NO. 364.

AREA	K. W.	AREA	K. W.	AREA	K. W.	AREA	K. W.	AREA	K. W.	AREA	K. W.
6.15	0	9.78	55	13.86	105	18.7	155	24.5	205	30.35	255
6.42	5	10.15	60	14.31	110	19.2	160	25.1	210	30.9	260
6.7	10	10.43	65	14.75	115	19.8	165	25.6	215	31.55	265
7.05	15	10.91	70	15.2	120	20.4	170	26.1	220	32.2	270
7.4	20	11.3	75	15.7	125	20.95	175	26.65	225	33.0	275
7.74	25	11.7	80	16.2	130	21.5	180	27.2	230	33.8	280
8.08	30	12.15	85	16.7	135	22.1	185	27.8	235	34.75	285
8.41	35	12.52	90	17.2	140	22.7	190	28.4	240	35.1	290
8.74	40	12.97	95	17.7	145	23.3	195	291	245	35.8	295
9.08	45	13.42	100	18.2	150	23.9	200	29.8	250	36.6	300
9.42	50										

The 5 K.W. steps in the table given here were obtained by the pen of the meter, keeping the tracing point of the readings in half and adding to the next of the 10 K.W. readings under consideration. For an illustration, area of the 170 K.W. line equals 20.4 sq. in., and of the 180 K.W. line equals 21.5 sq. in. 21.5 — 20.4 = 1.1 ÷ 2 = .55 sq. in.; 20.4 + .55 = 20.95 sq. in. area for 175 K.W. Finer readings than this can be easily estimated.

When the table has been prepared and ready to average a chart, place it and the instrument in the same positions as was done in making the table. Trace the curve drawn by the pen of the meter, keeping the aracing point of the planimeter as near the center of the curve or record line as possible. Make one complete round of the curve and

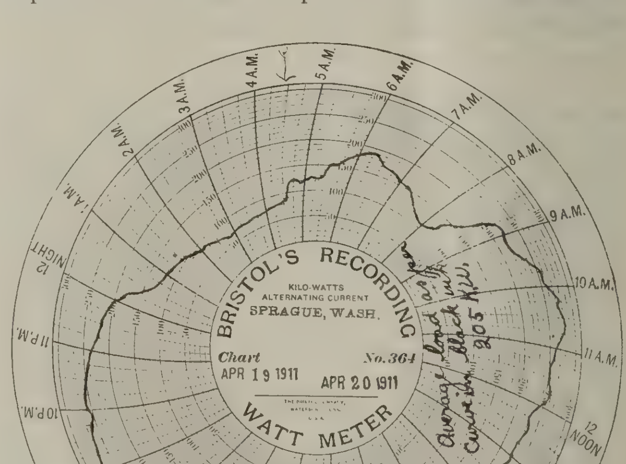


FIG. 1. A BRISTOL KILOWATT CHART.

back to the starting point. In case the curve or record line on the chart is mostly above 150 K.W. it would be necessary in most cases to divide it in half and trace each half separate, and add the result for the total area. Take this area and compare it with the table and opposite a like area on the table you will read the average in kilowatts.

For instance suppose we trace the curve drawn on a No. 364 chart and the area is 24.5 sq. in. Turning to the table, opposite 24.5 sq. in., we read 205 K.W., which is the average load. Again suppose we trace a curve and our planimeter reads 16.45 sq. in. Turning to the table we see this is half way between the areas of 130 and 135 K.W., therefore the average is 132.5 K.W. For kilowatt-hours multiply the average kilowatts by the total hours of the chart. While this method is not perfectly accurate it is so near that it is reliable enough for any ordinary purpose and in fact most anything outside of a laboratory test.

The H. M. Byllesby and Company's Annual Convention at Chicago.

The annual convention of H. M. Byllesby & Company and affiliated utility companies held at Chicago, January 2 to 5, 1912, marked the tenth anniversary of the organization. When Chairman T. K. Jackson of the Mobile Electric Company, of Alabama, called the convention to order 255 delegates were present, representing 40 groups of electric, gas and street railway properties in 18 states of the west and south. Prominent men outside the organization present as guests included Thomas A. Edison, president; C. A. Coffin, of the General Electric Company, President E. M. Herr, of the Westinghouse Electric Manufacturing Company, President John F. Gilchrist and Secretary T. C. Martin, of the National Electric Light Association, J. B. Forgan, George M. Reynolds and Charles G. Dawes. The presence of Thomas A. Edison, who seldom attends public gatherings, is considered one of the greatest compliments which could be paid to the Byllesby organization. It came about through the fact that Henry M. Byllesby was one of Edison's assistants in the pioneer days of electrical development. Although the two parted business association years ago they continued their friendship.

Following an address of welcome by Mr. Byllesby in which he summarized the remarkable growth of the organization, and reiterated his belief that successful utility operation must rest upon clean, liberal and progressive management, the delegates proceeded to a program of papers, discussions and addresses lasting four days. This year the program was devoted largely to questions affecting points of contact with the public, quality of service, regulation by state commissions and the efficiency and welfare of employes, there being only two strictly technical papers. Among the men outside the company who addressed the convention were George B. Caldwell, Samuel Insull and B. E. Sunny of Chicago, J. R. McKee and T. C. Martin of New York, and John F. Gilchrist of Chicago.

The convention program was as follows: "Staff Cooperation Toward Better Relations and Increased Efficiency of Employes," by W. R. Molinard, Oklahoma City, Okla. "Points of Contact with the Public," by W. H. Hodge, of Chicago; "Present Day Jurisdiction of State and Municipal Bodies Over Public Service Corporations," by Isaac Milkewitch, of Chicago; "Steam Heating Economics," by A. E. Stevens, of Minot, N. D.; "Suburban Distribution of High Pressure Gas," by H. H. Jones, of San Diego, Cal.; "Ways and Means of Building up Business in Small Towns," by H. E. Morton, of Albany, Ore.; "The Accountant in Public Service," by B. W. Lynch, Bluefield, W. Va.; "Our Appraisal Work During 1911," by Harold Almert, of Chicago; address of Gen. Geo. H. Harries, of Louisville, Ky.; illusrtated lecture on Engineering, by O. E. Osthoff, of Chicago; Illustrated Lecture on New Business Methods, by E. L. Callahan, of Chicago; "The Attitude of the Manager Toward his New Business Department," by Alex. F. Douglas, of Portland, Ore.; "The Byllesby Employe's Investment Clubs," by R. J. Graf, of Chicago.

The Philadelphia Electric Company Section of N. E. L. A.

Notwithstandnig the extremely busy times coincident with the holiday season, particularly among the central station men, the month of December found the Philadelphia Company Section holding its usual meetings, and all were very well attended. The commercial department branch listened to a thoroughly prepared and most instructive paper on "Corporations" by Mr. C. J. Russell, who is the possessor of the first Dougherty medal. Thorough research is a habit with Mr. Russell, and that the evening was profitably spent may be understood without further comment.

The meter department branch meeting was well attended and Mr. Elmer L. Kyle of the laboratory presented the paper entitled "The Errometer." The Errometer (error-meter) is a practical and scientific instrument which was designed and constructed in the meter department of The Philadelphia Electric Company. It is used for "testing meter testers" and for determining the accuracy of the various methods of meter testing. This is the first instrument available for making determinations of this character and the results are obtained in a manner which permit of analysis. The various errors can be tabulated separately and the personal errors of meter testers determined. The instrument is essentially of the high speed motor-driven recording type having a multiplicity of syphon pens operated by electro-magnets. Its inherent inaccuracy does not exceed 1/100 of one per cent.

The paper was exceedingly interesting and considerable discussion followed. Mr. Kyle demonstrated the use of the Errometer and gave the results of many tests that have been conducted, thus showing the value of such an instrument in making determinations which have heretofore never been possible.

Cornell Alumni Dinner at A. I. E. E. Meeting in New York City.

The Cornell Alumni in attendance at the monthly meetings of the American Institute of Electrical Engineers in New York are forming the habit of getting together for dinner at the Cornell University Club, 65 Park Ave. A large and representative attendance has already been built up and all are enthusiastic as to the possibilities of the plan in promoting interest in the Institute, and in forming and renewing college ties. Cornellians who expect to attend the reunions should notify the steward of the Club a few days in advance, and for the purpose of these reunions the Club has extended its privileges to non-member Cornellians.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

CONDENSING PLANT VS. NON-CONDENSING.

Editor Southern Electrician:

(272) Kindly present information on the following conditions. In our plant there is a 2,000 K. W. turbine exhausting into a heating system about 140 days of the year. Will it pay to install a condenser for the remaining 225 days? What would be the yearly gain or loss in dollars, in case the condenser is installed? The labor cost may be assumed the same in both cases, so that only coal cost, water cost, and charges against first cost of change need be considered. The turbine running non-condensing uses 38 pounds steam per K. W. hour. The temperature of feed water supply is raised to 210 degrees and the water cost 13 1-3 cents per 8,300 pounds. The boiler pressure is 150 pounds. Coal costs $3.00 per ton. Plant operates 10 hours per day. P. H. T.

DETERMINING SIZE OF POWER CABLE.

Editor Southern Electrician:

(273) Please publish a formula or method of determining the size of lead covered cable to transmit a certain maximum three-phase load. Assume a particular case and illustrate the method. A. C. D.

SIZE OF LINE FOR D. C. MOTOR.

Editor Southern Electrician:

(274) It is required to run a line one mile from our plant to a factory and operate a 220 volt, 40 H. P., D. C. motor. I have estimated by use of tables that No. 00 wire will be sufficient. Kindly check this and publish a formula or any other definite means of finding the proper size of wire. It is possible that about 50 additional H. P. may later be connected, should this be considered in the design of the line at the present time? S. P. D.

LIFE AND CANDLE POWER OF TUNGSTEN LAMPS VS. CARBON LAMPS.

Editor Southern Electrician:

(275) I would like to obtain information in the form of a table or a curve showing a comparison between tungsten and carbon lamps giving useful life, wattage and candlepower for 90, 100 and 105 per cent of normal voltage. If given in the form of curves plot them for tungsten and carbon lamps on same sheet with hours' life as base dimension and watts and candlepower as vertical dimensions. R. H. C.

TESTING WIRING SYSTEM FOR GROUNDS AND SHORT CIRCUITS.

Editor Southern Electrician:

(276) I would like to secure a method of testing an iron conduit system of wiring, both light and power for the purpose of locating a ground or a short circuit. If methods vary for different systems explain the differences. OSCAR LOWERY.

SIZE OF MOTORS FOR PUMPS.

Editor Southern Electrician:

(277) The writer desires information in regard to the most satisfactory type of motor for operating pumps, whether alternating or direct current. The pump is of the Gould design and must be started against a full discharge pipe. Kindly furnish a formula if possible and give other data necessary in determining the size of motor. F. W. T.

Horsepower of Three-Phase Motor, Ans. to Ques. No. 203.

Editor Southern Electrician:

Apparently H. A. B. wishes first to know how to determine the horse power of the various motors required. If steam, or gas, or oil engines are at present used to drive the mill, the requisite horse power can be determined by taking indicator diagrams from the prime mover under various load conditions, subsequently making allowance for the probably higher efficiency of utilization of power from the motor shaft to the various machines over that existing in steam driven mills. If water power is utilized, an approximate calculation of the horse power at present used may be made from a knowledge of the type of turbine or water wheel and the mean head and flow of the water. Considerable care must be exercised in such an estimate and it will often be preferable to make some kind of dynamometer test at the various machines driven, depending upon the nature and arrangement of the latter, thus arriving at the power consumption of the various units and groups.

If the mill is not yet constructed, the probable horse power required must be estimated by an examination of reports of existing mills of similar size and output operating under similar conditions. In any case, allowance must be made in the distribution system for such extensions as will probably become necessary in the future and, when adopting electric drive, advantage must be taken of the suitability and preference of various machines for individual or group drives as the case may be.

The horse power of a star wound three phase motor is given by the following formula: $H.P. = 0.00232 \times V. \times C. \times P.F.$ where:—

V=Voltage between phases

C=Amperes per supply lead

$P.F.$=Power factor of motor.

Hence, in designing the cables for a motor of a certain H.P. as N, the current per main $= C = 746 \times N/V \times PF \times \sqrt{3} = 430\ N/V \times PF$ = amperes, and, allowing a current density of 1000 amps. per sq. inch, the copper section per load $= A = 0.43\ N\ (1 + P/100)/V \times PF$ sq. ins., which allows for an overload of P per cent. (For further information in this connection, H. A. B. would do well to refer to the reply to Question 174, published in the March issue of this journal.)

High conductivity, tinned copper conductors should be used and the insulation and mechanical protection may be: (a) Pure and vulcanizing India rubber and tape, the whole

vulcanized together, braided and compounded; or (b) Pure and vulcanizing India rubber and tape, the whole vulcanized together and sheathed with lead. (This cable may be used if much damp is prevalent). If much mechanical misuse is to be anticipated, flexible steel wire armouring may be added to the cable, otherwise protected as in (a) or (b). It would certainly be advisable to lay the cables in pipes or troughs along the floor beneath or set flush with the latter if possible, otherwise covered with battens to prevent tripping. Wires dangling from the ceiling have a slipshod appearance, and what is more serious are liable to get in the way and cause more or less serious accidents to workmen or materials, apart from being themselves more exposed to damage. CEC. TOONE.

Operating Costs of Units. Ans. Ques. No. 253.

Editor Southern Electrician:

In answer to question 253 in the November issue of SOUTHERN ELECTRICIAN, would say that as the question has not stated the price of electricity per kilowatt-hour or gas per thousand feet, it is quite out of the question to give even an approximate cost of operation of the several units called for. However, I will try to give a little information on cost of installation.

Taking the steam unit first, a steam engine of 25 horsepower would be rather the most expensive, in installation, maintenance, efficiency, etc. Working at a load factor of 50 per cent it would have a very low efficiency and the cost of generating a horsepower at the driving pulley would be very high. Now if the power generated could be made a secondary item, if the exhaust steam could be used to a good advantage, or if live steam were used in the plant in quantities great enough to offset that required for the generation of power, then the operating cost would be greatly reduced. For instance, in the case of a laundry, where so much steam is used, the price of power generated is of secondary consideration and is quite often figured as being of small expense.

Now as to cost of installation, exclusive of boiler, pumps, etc., a simple throttling engine would cost from \$5 to \$10 per horsepower, simple high-speed from \$10 to \$15 per horsepower, simple Corless \$20 to \$25 per horsepower. The throttling engine as well as being the cheapest, would be the best, that is, if the exhaust steam could be used as has been stated, and steam consumption per horsepower per hour is of little consideration.

The gas engine, while costing a little more, from \$30 to \$40 per horsepower, would be of higher efficiency working at that load factor, the gas consumption being probably from 15 to 25 cubic feet per horsepower hour, depending upon the mode of governing and heat value or number of B. T. U.'s in the gas. I can cite an instance of a 40 horsepower, 2-cylinders, 4-cycle gas engine, direct connected to a 27.5 kilowatt generator, working under a 50 per cent load factor on illuminating gas, throttling governor, gas containing from 470 to 525 B. T. U.'s per cubic foot, which consumes about 18 cubic feet per horsepower hour.

Now as to electric drive, the motor installation would cost from \$20 to \$25 per horsepower. This, of course, represents the ideal drive, it being the more flexible of the three. The motor requires no expensive foundation, and it need not take up valuable floor space, as it may be suspended from the ceiling or side wall and will work just as well. It does not need a great deal of attention, beyond an occasional oiling and dusting, is not noisy and does not lay down and die like a gas engine will, if a little overloaded.

If the motor is to be of the direct current type, the efficiency would be much higher, worked at that head factor than an induction motor of the same size. Taking all fixed charges into consideration, the motor drive is far ahead of either of the others. G. I. MORGAN.

Operating Costs of Units, Ans. Ques. No. 253.

Editor Southern Electrician:

It is a well-known fact and a well-worn experience that most manufacturers are very shy in letting the world at large learn what savings they are effecting by the substitution of electric for steam, gas, or other form of engine power to drive the machinery used in various businesses. The reasons for this reticence on their part are easily enough understood by those who know what that "blessed" word competition really means to the average manufacturer in general and to his salesmen in particular. Nothing, therefore, that can possibly help his rivals in the same line of business, to cheapen their cost of production, must be forthcoming at the manufacturer's hands, lest he be the first to suffer by such generosity. But, fortunately, here and there, electric power suppliers can obtain the experiences of electric power users who have nothing to fear from letting the whole world into their confidence on such matters, their success or non-success in the competitive struggle for business depending on totally different factors to those referred to above.

In regard, therefore, to question 253, published in the November issue, I submit the following as information or for criticism as it may please your readers. I am thoroughly aware of the fact that results from no two sections are likely to agree, and we all can profit by a frank analysis of each others opinion and results. It is on this account, therefore, that I hope someone may disapprove of my data, furnishing other with the reasons for or against.

The following data is given for a 25 horsepower gas engine, and the same horsepower steam engine and electric motor operating at 50 per cent load factor, 10 hours per day, 26 days per month.

The cost of gas engine complete is taken at \$1,200. Details of monthly cost of running are:

Gas at \$1.00 per M.	\$ 71.50
Oil, waste and incidentals	4.50
Water	3.00
Labor	8.00
Repairs, average of five years	5.00
Interest and depreciation, 15 per cent	15.00
	\$107.00

The cost of steam engine, boiler not included, is taken at \$1,000, erected. Details of monthly cost of running are:

Fuel	\$ 46.70
Oil, waste, packing	7.50
Water	4.00
Labor	60.00
Repairs, average of five years	5.00
Interest and depreciation, 10 per cent	8.33
	\$131.53

The cost of electric motor and wiring is taken at $435. Details of monthly cost of running are:

Electric current by contract at 4 cents per K. W. Hr.	$ 97.50
Oil	.10
Repairs and brushes	.50
Interest and depreciation, 10 per cent	3.60
	$101.70

By installing several smaller motors in place of one large motor and eliminating shafting, this amount may be reduced from 10 per cent to 50 per cent.

The items charged to the units above are only those that directly effect operation and can rightly be charged to the production of power by the unit. The items to be charged to the power account of a steam plant are as follows and divided into operating and fixed charges.

Operating Expenses. (1) Superintendence, or time of manager who looks after the purchasing of supplies for the plant and watches its economical operation; (2) wages of engineers and engine oilers; (3) wages of firemen and coal passers; (4) fuel; (5) cost of removal of ashes; (6) water for boilers; (7) repairs to engines, boilers, pumps, belts, shafting, and auxiliary apparatus; (8) incandescent lamp renewals; (9) arc lamp globes and repairs; (10) oil, waste, packing, etc.; (11) insurance, fire and boiler.

Fixed Charges. (1) Interest on plant equipment at 5 per cent; (2) depreciation on plant investment at 10 per cent; (3) rental value of space occupied by plant if plant building is rented, if owned value of space for other operations; (4) insurance against damage to employees by accident; (5) taxes on plant at 1½ per cent.

The fixed charges above are made out for a steam plant with mechanical drive, which could operate by motor equipment and central station power. It must be remembered further that increased production of about 10 per cent, in the case of the motor operating at a high efficiency compared with the other units, can be capatilized and credited to the operation expense.

H. L. Williamson.

Combined Cost of Power and Lamp Renewals, Ans. Ques. No. 254.

Editor Southern Electrician:

I notice that in No. 254, E. J. B. wishes data on cost of power and lamp renewals. Perhaps the following data will be of some assistance. In determining the cost for a certain number of hours the following formula is useful:

$$C = I[(t \times c/T) + (t \times p \times c'/1000)]$$

In this formula C is the total cost of light used in t hours; c is the cost of the lamp per candle power; T equals the useful life of the lamp in hours; p, the initial consumption in watts per candle power. For ordinary work the initial consumption in watts per candle power for the various lamps on the market is, for the carbon filament, 3 to 45; graphitized, or sometimes termed metalized filament, 25; tungsten, 1.25. These comprise the commercial lamps with the tantalum 2.2 to 3. The osmium and zirconium filments with a consumption of 1.5 and 1 watt per candle power, respectively, are used sometimes in the smaller units.

Useful life of carbon lamps means the number of hours which a lamp will burn before it loses 20 per cent of its initial candle power, after which its efficiency is usually so poor that it is better economy to discard it. This is known as the "smashing point." Actual life should be distinguished from useful life very carefully and means the number of hours the lamp will burn before the filament breaks. Ordinarily this is taken to be about 800 hours. Another good way to figure the useful life of a lamp is to consider it as the number of hours which will make the average cost per candle power a minimum. The following equation will be of assistance in determining this:

$$T = \sqrt{(2000\, c/c' \times P)}$$

In which T is the useful life, c the cost of the lamp per initial candle power, and P the increase in consumption in watts per candle power, and c′ the cost of energy per kilowatt hour. Assuming, for example, a lamp costing 16c and giving 16 initial candle power, and the consumption increasing 1 watt per candle power during 500 hours of burning and the price of energy as being 10c per kilowatt hour the useful life would be,

$$T = \sqrt{(2000 \times 1)/10 \times 200))} = 316 \text{ hours.}$$

Of course with this method of calculating it, expensive lamps with cheap energy would mean an increase of useful life.

Taking again, for example, a useful life of 800 hours and good, steady voltage regulation, the consumption of a lamp which will make the total cost of lighting a minimum can be readily determined by the following formula, when the price charged per kilowatt hour for energy is known. Therefore, the cost for light for t hours in cents, equals:

$$C = [(t \times c/800) + (t \times p \times c'/1000)]$$

In which t is the number of hours the light is used, c, equals the price of the lamp, and p is the initial watt consumption, and c′ the cost of energy in cents per kilowatt hour.

Geo. I. Morgan.

Lighting Layout for a Cotton Mill, Ans. Ques. 257.

Editor Southern Electrician:

In regard to the above question, in the November issue, the first thing to decide in this problem is the required intensity, which for a weave room should not be less than 4 or 5 foot candles. Since it requires one effective lumen to produce one foot candle on a square foot of surface, and since this room contains 9,600 square feet, we see that the effective lumens required will be 38,000 to 48,000. The next question is to determine the necessary watts to be expended in order to produce this effect. Considering the size of the room, we cannot figure on any reflection from the walls, and while the ceiling might aid when freshly tinted, the color and reflecting power of such a surface is so likely to change or become obscured that it is not safe to figure much on it. It would, therefore, be better to use a steel reflector and not allow any of the light to be directed towards the ceiling. With tungsten lamps and an efficient reflector, we should be able to obtain five lumens per watt, which gives us as the energy required, 9,600 watts.

The spacing and the number of units required depends, of course, upon local conditions. It is better to use as large a size of lamp as possible, and yet get an even distribution. With this height of ceiling, a lamp should be able to illuminate a space 15 × 16 feet, which would require, therefore, 40 lamps, arranged as shown in Fig. 1. These units should be 250 watt units, with some good reflector, such as holophane steel reflectors, AE. 250, and should be hung about one-half as far above the plane of

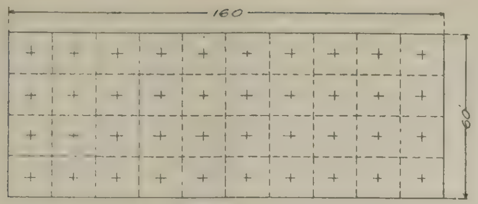


FIG. 1

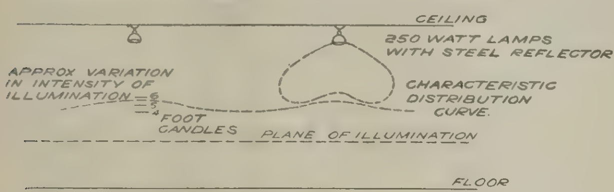


FIG 2

Fig 1. Lighting Layout for Cotton Mill Weave Room. Fig. 2. Variation in Intensity of Illumination for a Layout.

illumination as the horizontal spacing. Taking the plane of illumination as three and a half or four feet from the floor, this would bring these lamps one foot below the ceiling, which is a very convenient distance for a short chain drop, or close ceiling fixture. If for any reason this should be too great a spacing, the rooms could be arranged in spaces 12 x 13½ feet, the lamps being in five rows of 12 each, or a total of 60 lamps, each of 150 watts, which would give a little less wattage for the room. In this case the lamps should be hung about two feet from the ceiling. I consider the former layout preferable. In many cases there are certain arrangements of aisles, bays, etc., that call for a rather arbitrary arrangement of the units, irrespective of the theoretical spacing, but this of course cannot be designated without knowing the conditions.

In the room below, which is more or less obstructed by the belting, I should think the same arrangement would answer as given for the room above, except that the position of some of the lights might have to be changed to avoid casting shadows. If there are a good many obstacles to the light, it might be necessary to use quite a different arrangement, such as, say, 96 100-watt lamps, each illuminating a space ten feet square. Such arrangement would cost considerably more to wire and install, as well as more for lamp renewals, than the arrangement with the larger units and would not give in general any better distribution. A. G. Rakestraw.

Operation of Motor Generator and Turbine, Ans. Ques. No. 259.

Editor Southern Electrician:

Referring to question 259, it is evident that as the voltage of the railway unit diminishes, owing to the momentary decrease in speed when heavy loads come on, the field of the motor will be weakened also, provided it is not considerably over saturated, so that the counter emf. of the motor will not rise above that of the railway generator sufficiently to cause a reversal of current. In actual practice the result would be to diminish the driving power of the motor and thereby transfer part of the A. C. load to the turbine generator until the engine governor re-adjusts the speed.

If the field is operated much above the saturation point there would be a large transfer of load, but the motor is not likely to generate a sufficient counter Emf. to cause a reversal even with extremely poor governing characteristics of the engine because the lower the emf. of the generator, the weaker will be the field of the motor.

Transformer Connections and Voltages—Ans. Ques. No. 260.

It will be perfectly practicable to operate three transformers as outlined in question 260. With a ratio of the transformation 25 to 1, the secondary voltage of each would be 6,600/25 which equals 264 volts. By connecting the secondaries in "Star" the resultant voltage would be 264 x 1.73 equals 457 nearly. Any variation in primary voltage would, of course, vary the secondary voltage so that there would be no difficulty in maintaining a secondary voltage of 460, as desired.

However, the output of the transformers in kilowatts would be less than their rated capacity in the ratio of 6,600 to 11,500, or approximately one-half, since the current carrying capacity of the primary remains the same regardless of the voltage. It would be well to open the transformers and see if they are not provided with taps permitting the primary coils to be placed in parallel and in such case it would be better to change their connections so as to utilize their full capacity. If there is no terminal block permitting this change, it might still be a simple matter to open the primary windings at the middle points and connect the two windings in parallel.

Speed Control of Shunt Motor.—Ans. Ques. No. 263.

Referring to question 263, the simplest way to lower the motor speed within reasonable limits would be to place a rheostat in the armature circuit, the coils of which will carry the armature current continuously without overheating. This method would reduce the power of the motor somewhat and the feasibility of the plan depends on whether or not the reduction in power would be permissible. A small rheostat connected in the field circuit would increase the speed of the motor, but at a sacrifice of running torque. C. H. Broward.

Transformer Connections, Ans. Ques. No. 260.

Editor Southern Electrician:

Permit me to submit the following answer to question No. 260 by E. W. C. in the December issue of Southern Electrician. Single phase transformers may be connected to the line in a number of different ways, some of which are as follows: Star primary; star secondary; delta primary; delta secondary; star primary delta secondary; and delta primary star secondary, however the most usual way when transformers are wound in 10 to 1 ratio is the delta using rather low voltages such as 2,200.

In order to demonstrate clearly the manner in which the secondary voltages vary using the connections as above named the following diagrams are given. It has been assumed that the transformers are connected to a three-phase transmission line whose voltage is that given by E. W. C., 6,600 at 60 cycles and the transformers are single phase with a 25 to 1 ratio. In Fig. 1, the primary and secondary of each transformer are connected in star, therefore the voltage received by the primary coils is equal to $6{,}600/\sqrt{3}=3810$ This is easily seen from the fact that two winding are in series between each pair of conductors in the line, the voltage in the secondary windings will be equal to $3810/25=152$ and the resultant emf in the secondary circuit $= 151 \times \sqrt{3} = 263$. Fig. 2 illustrates the three transformers connected

with their primaries in star and their secondaries in delta, the voltage in the primary coils is the same as that shown in Fig. 1, or $6{,}600/\sqrt{3} = 3810$ and the voltage in the secondary windings $= 3810/25 = 152$ volts. Since only one coil is between every two secondary conductors the emf will be the same as in secondary winding or 152 volts.

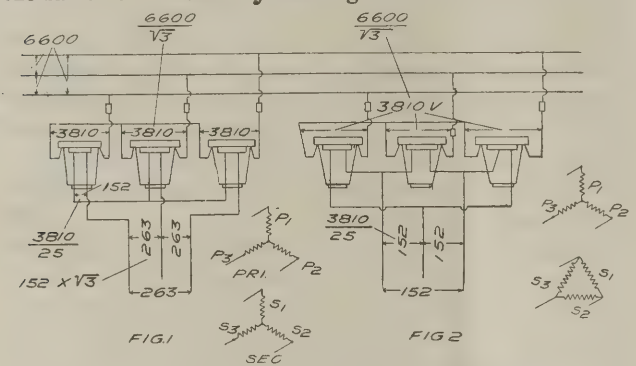


FIG. 1. PRIMARIES AND SECONDARIES CONNECTED IN Y; FIG. 2. PRIMARIES IN Y SECONDARIES IN DELTA.

In Fig. 3 the transformers have both their primary and secondary windings connected in delta, the voltage impressed on the primary winding is the same as that of the line, which is in this case 6,600, the voltage received by the secondary conductors is the same as that of the secondary coils, but in proportion to the number of turns or ratio of transformation, 25 to 1, or $6{,}600/25 = 264$ volts, when connecting transformers in this method the load must be kept balanced, otherwise the voltage will not be the same in each leg of the secondary circuit. This also is true of the star method of connection unless a fourth wire is added to the neutral point.

Fig. 4 illustrates the transformers connected as suggested by E. W. C. in the question. The primary coils are connected in delta and the secondary coils connected in star. The voltage impressed on the primary windings will be the same as that of the line, for the reason that in this connection there is only one winding between any two conductors of the line, the voltage therefore will be equal to 6,600, but that in the secondary winding equals $6{,}600/25 = 264$. Since there are two secondary coils between any two secondary conductors, the voltage will equal $264 \times \sqrt{3} = 457.2$ or almost 460 volts.

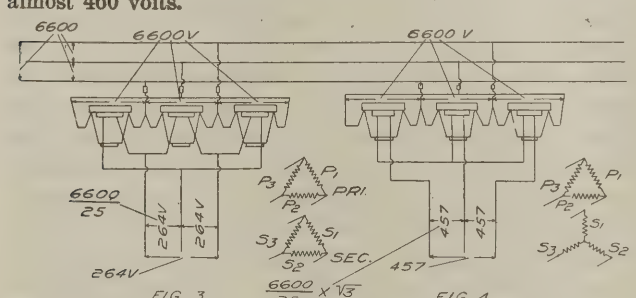


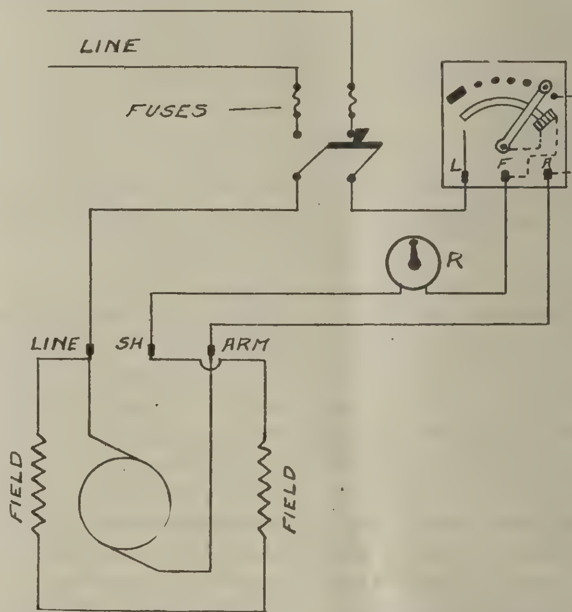
FIG. 3. PRIMARIES AND SECONDARIES IN DELTA; FIG. 4. PRIMARIES IN DELTA SECONDARIES IN Y.

It must be remembered that in the above calculations all losses in the transformers have been neglected, and the results are only approximate. It may be of interest for E. W. C. to refer to answer to question 236 page 121 in the September issue, by the writer. E. J. MORA.

Speed Control of Shunt Motor, Ans. Ques. No. 263.

Editor Southern Electrician:

In reply to question 263, of the December issue, a motor should always be protected from overload by an automatic starting box with no voltage release, which automatically allows the starting lever to return to the "off" position when the circuit is broken. A starting box with an overload cut out to break the circuit in the event of an abnormal rush of current should be used. For speed control within certain practical limits a field regulating rheostat should be used and placed in series with the shunt field coil circuit.



METHOD FOR CONTROLLING SPEED OF SHUNT MOTOR.

An arrangement showing the connections of a two pole shunt wound D. C. motor with field rheostat and starting box with no voltage release is illustrated in the accompanying diagram. This provides for a speed variation by field circuit control, which is more economical and much preferable for small motors than a rheostat, inserted in the armature circuit. You can operate at constant speed by this arrangement by having the field rheostat regulator in the "no resistance" position obtaining a variation of speed at different positions of the field regulator.

To start: See that the motor starter handle is in the "rest" or "off" position. Close the double pole single throw switch in the main supply circuit, then gradually rotate the motor starter handle lever from the "off" to the full "on" position, allowing the motor to speed up between each contact stud. To vary the speed of the motor, rotate the lever handle of the field rheostat. To stop, open the main circuit by means of the D. P. S. T. switch; when the motor starter lever ought to fly back to the "rest" or "off" position. WM. R. BOWKER.

Speed Control of Shunt Motor, Ans. Ques. No. 263.

Editor Southern Electrician:

The speed control of a standard shunt motor may be accomplished by varying the voltage at the motor terminals or by varying the magnetic lines of force in the field poles. Where the supplied voltage is constant, as is ordinarily the case, the voltage at the armature terminals can be varied by inserting a variable resistance in the armature circuit. This resistance causes a drop in voltage which is directly proportional to the product of current and resistance. $E = IR$. By inserting resistance in the armature circuit the speed of the motor

can be only lowered, and the maximum speed will be reached when all resistance is cut out. This method of control is wasteful of electrical energy. The watts loss $= I^2R$. However, when a constant speed is required most of the time, there should be no objection to resistance control, especially for small motors.

To vary the speed of a shunt motor by varying the field strength, a variable resitance may be inserted in the field circuit . As the resistance is increased, the current will decrease and a corresponding decrease in the field flux will follow. As the field flux decreases, the armature speeds up in order to generate the required back electromotive force. By weakening the field flux in this manner, the speed of the armature is increased above the normal speed rating of the motor. Where field control is used, mechanical construction of the armature should be such that a good margin of safety is left when operating at maximum speed. Where a wide range of speed is desired both of the above methods are generally used. For the two horsepower motor under question I would advise the use of a standard 2 H. P. rheostat.

A. L. UTZ.

Winding for Induction Motor, Ans. Ques. No. 270.

Editor Southern Electrician:

In reply to question 270 in the January issue, the sketch below is submitted to show the winding best suited to the conditions named. The continuous lines represent the regular winding which should be used and consist of turns of No. 26 or 28 wire. It is best to use silk covered wire in this case and fill the slots full excepting the one containing the small coil of each pole where space should be left to wind the teaser winding as shown by the dotted lines. For the teaser or starting winding, No. 30 or 36 wire or any intermediate size may be used. In placing this winding care must be taken to wind enough turns so that a short circuit is not effected, otherwise the design of the teaser winding is not important as the circuit breaker automatically cuts it out when the motor reaches a certain speed.

The connections which should be made are as follows:

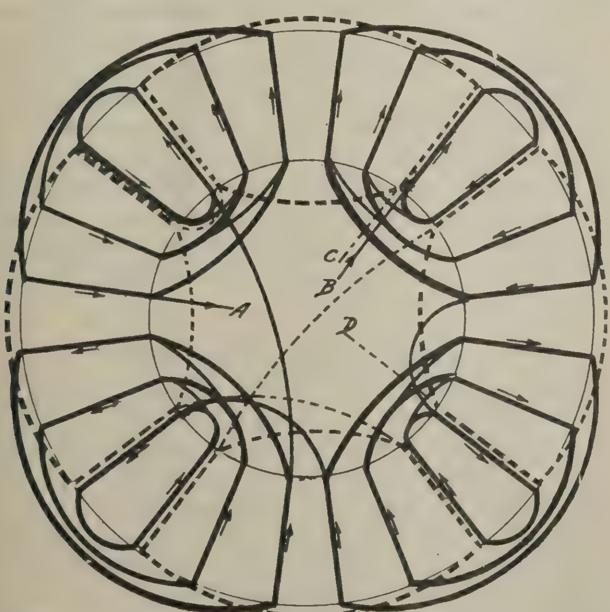


DIAGRAM OF INDUCTION MOTOR WINDING FOR 1/8 H. P., 1,800 R. P. M.

Connect lead A and B direct to the line. One of the teaser leads, C or D must be connected to the circuit breaker and then to the line in such a manner that the teaser winding will be open circuited when a certain speed is reached. The other teaser lead connects direct to the line. If the motor runs in the wrong direction, reversal can be made by reversing either the teaser or the main leads.

C. H. BROWARD.

Remarks on Convention of Georgia Section of N. E. L. A.

Editor Southern Electrician:

I have read very carefully the report of the Georgia Convention of N. E. L. A. in the November issue, and believe it to have been well proportioned, as regards the relative amount of time given to engineering, commercial and general management affairs. I certainly agree with your past president, Mr. Bleecker, that the local section should by no means feel obliged to confine their discussion to local matters, but that any subject whatever in which the members may be interested and which has not recently been threshed out by the national body, can and should be discussed, often with more profit to the members of the local section than could be done in the larger meetings. Only two of the papers at your convention could be considered local in their character.

As regards the insurance situation, we regard the inspection here as a necessary evil. Of course we could not say, let us abolish it, but when we get up against some particularly capricious and arbitrary inspector we feel like telling him some things. Furthermore, the rates charged are too high. When we run in an outlet for an iron, for instance, at a cost of, say, $2.50 and have to add $1.50 for inspection, making the cost to the customer $4.00, we are tempted to think, "Is it worth while." As regards cooperation, surely we must have it. From what I have seen of municipal inspection, I prefer it. In Pittsburg, the inspection is made by the city Bureau of Electricity, and is free. The underwriters accept the inspection by the city, and every one is satisfied.

The other articles were interesting and important. I note that the General Electric and the Westinghouse Companies each presented a paper, which helps to give interest and variety to the proceedings, while the paper on wave form brought in some of the more scientific points. Altogether, as I have said, it seems to have been a well balanced program, and I wish you another successful year.

A. G. RAKESTRAW.

Electric Light for Sterilizing Milk.

Consul Frank W. Mahin, Amsterdam, Holland, reports that a local periodical refers to the effect of ultra-violet beams on bacteria and to the fact that such beams are abundantly developed by mercury incandescent lamps, and relates that through this medium milk may now be sterilized in a few minutes. An apparatus has been constructed, it is explained, whereby the milk flows in a thin stream along an electric light. Demonstrations were first made with water infected with different kinds of bacteria, and it is said that the water was purified in a few minutes, without appreciably increasing its temperature. The result is attributed to the quality of the ozone formed under the influence of the light, but the demonstrations must be conducted where there is sufficient room for the light to burn freely.

New Apparatus and Appliances.

Improved 2,500 Volt Noark Primary Fuses and Fuse Boxes.

With the invasion of electricity into suburban territory for light, heat and power, the central station man or superintendent of distribution has been confronted with many problems. Some of these he has been able to solve on the ground, whereas in the solution of others he has found it necessary to call on the manufacturers of electrical apparatus to design devices to meet his particular requirements. As an illustration of the point in question, the recent developments in 2500 volt fuses and primary fuse blocks manufactured by the H. W. Johns-Manville Company, of New York, are of interest.

After a careful study of the prevailing conditions and exhaustive tests on many of the largest aerial and underground systems in the country the Johns-Manville Company has brought out a line of single pole primary boxes and 2500 volt fuses which are designed with such ample factors of safety that they may be relied upon to meet not only most stringent conditions but to provide adequate protection under the increased severity which may be predicted for the years to come. These boxes are made in three sizes, having maximum ampere capacities of 30, 60

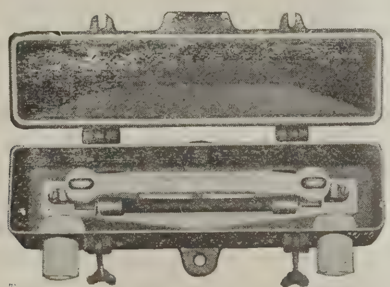


FIG. 1. NOARK SINGLE POLE FUSE BOX.

and 100 amperes. A complete line of fuses is made for each size in amperages ranging from the maximum down to ½ ampere. This is a feature which will be warmly appreciated by the central station man or superintendent of distribution, as it relieves him of the burden of replacing his fuse boxes with others of larger capacity as the load on his system increases, it being only necessary for him to estimate the maximum amperage that will ever be required at a particular installation, purchase the corresponding box and fuse it down to the proper point. As the load increases from time to time it will, therefore, only be necessary for him to change the fuses. For aerial lines these boxes are provided with porcelain bushings of very liberal dimensions, giving mechanical strength and abundant leak-

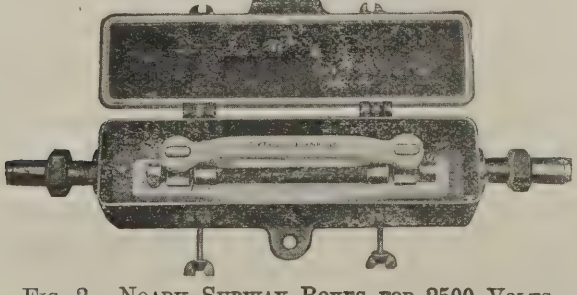


FIG. 2. NOARK SUBWAY BOXES FOR 2500 VOLTS.

age surface. These bushings are located either on one side of the box or at the top and bottom, according to a consumer's system of connection. Several styles of fastening lugs are offered electively as it has been found that ideas vary in this respect. For subway installation, these boxes are provided with unions on the outlets, same being located either at the ends or on the side optionally. This union is very simple, consisting of but three parts; the brass cable sleeve tinned to facilitate wiping a joint to the lead sheath of the cable, a male end screwing into the cast iron box with a Standard pipe thread and a hexagonal nut or shell. The joint between the male end and the cable sleeve is accurately ground to a perfect fit, thereby securing absolute water-tight properties without the use of a gasket of any form. All "Noark" primary boxes whether for aerial or subway work are equipped with doors hinged at the side and held closed by pivot studs and wing nuts against a tubular rubber gasket of high resiliency.

Granting the accuracy of the fuse and its ability to open the circuit quietly under all conditions, the two most important requirements of a primary fuse box are dielectric strength (between live metal parts and the iron) and safety to the operator. The "Noark" primary fuse boxes depend for their dielectric strength upon dry process glazed porcelain whose excellence as an insulator is

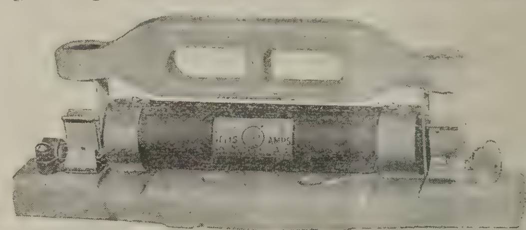


FIG. 3. SHOWING NOARK FUSE, FUSE CARRIER HANDLE AND FUSE BLOCK FOR 2500 VOLTS.

too well known to require discussion here, and upon air space which possesses the distinct advantage over all insulating compounds that it is not subject to deterioration in any form and cannot vary. The fuse is mounted in a porcelain carrier handle which provides absolute safety to the operator in its insertion and removal, as it allows him to manipulate the fuse without bringing his hand in proximity to any live metal or grounded parts. Each primary fuse box is tested at a potential of 10,000 volts (or four times the operating voltage) between live metal parts and the iron case.

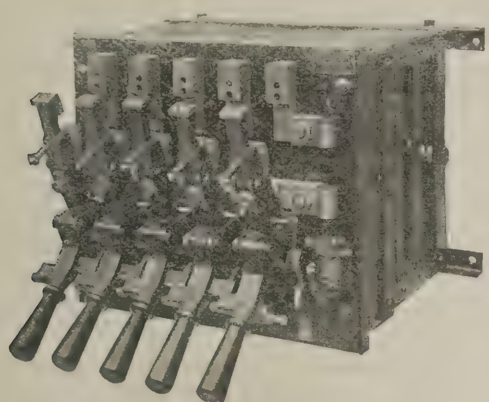
A New Kellogg Switch Box.

For the convenience of some of its customers who prefer a ten-line switch box equipped with shelf for plugs, The Kellog Switchboard & Supply Company of Chicago, has arranged and placed on the market such a box. This arrangement of cords takes less room below the cabinet on the wall and is preferred by some because of the added compactness. Some of the advantages claimed for this new ten-line switch box are: Extreme simplicity. No expert attention required in maintenance. Economy. Present central office telephone equipment can be retained in service if desired. No drops to be "restored" when patrons

are merely ringing other parties on their own line. All lines terminate at office on extension bells of same resistance as bells on the line. This insures balanced conditions and makes it possible for central to be rung as efficiently as any party on the line.

New Cutler-Hammer Multiple Switch Starting Rheostat.

Multiple switch starting rheostats differ from the ordinary type used for small motors in that the sliding contact is entirely eleminated and a series of individual switches, which cut out individual steps of resistance, substituted. The Cutler-Hammer Manufacturing Company has redesigned its entire line of multiple switch starters. In place of the lever closing upward, the present toggle joint, operated switch is closed by means of handles placed below the switch contacts. Instant and positive contact is insured.

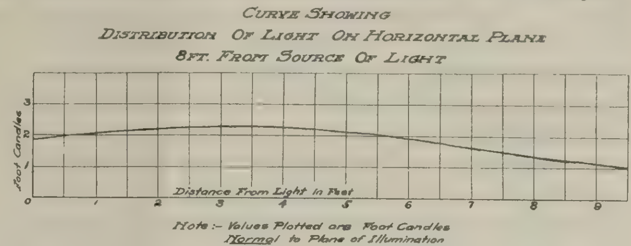


MULTIPLE SWITCH STARTING RHEOSTAT.

Because of the larger currents required by large motors the sliding contact starter is limited to small or moderate sizes. With the multiple switch starters there is no sparking in starting the motor. The illustration is that of a 75 H. P. 220 volt new type multiple switch starting rheostat. In starting the left hand switch is closed first, then the second, third, etc., allowing a second or two between. Each switch, by means of metal stops near the handles, holds the switch before it, in place. When the last switch is closed the no-voltage release magnet holds them all in contact and the entire resistance is short-circuited. The switches cannot be closed out of order and two or three switches, for instance, cannot be closed and the others left open. Releasing the hand from any handle except the last causes all switches to open. The motor cannot run with resistance in the circuit, and the resistance is, therefore, also protected from overheating. Overload release is also included in the various types made.

Light Distribution with a Haskins-Lucida Reflector.

What people who use light want to know is whether or not the use of certain glassware will allow them to distribute light widely and evenly. An answer is given in the curve plotted by the engineering department of the Haskins Glass Co., of Wheeling, West Virginia, from tests made at the Electrical Testing Laboratories on a Haskins-Lucida reflector fitted with a 250 watt clear bulb tungsten lamp. This shows that the foot-candles of light delivered on a working plane eight feet below the source of light are distributed with a remarkable uniformity, as the plotted line hugs the two-foot candle mark all the way from a point directly under the lamp to a circle six and one-half feet from the same. Even beyond the six-foot range the light drops off very gradually, reaching the single foot-candle value at a distance of nine and one-half feet. Of course, this chart, as reproduced herewith, represents the light delivered by a single lamp only and where a number of lamps are suitably spaced so that the rays of



CURVE FOR HASKINS-LUCIDA REFLECTOR WITH 250 WATT CLEAR BULB TUNGSTEN LAMP.

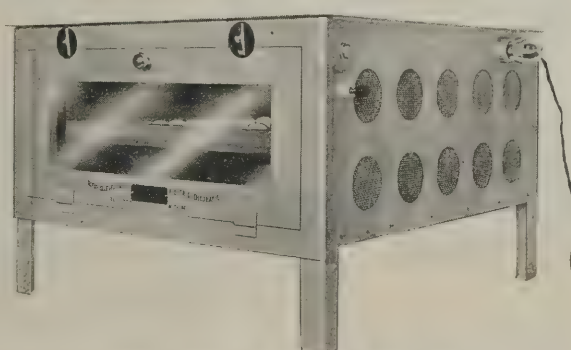
light will overlap, they would reinforce each other in producing an illumination in which the variation from an absolute uniformity could not readily be discerned by the human eye. The chart shown is based on tests of a bowl type No. 976 Haskins-Lucida reflector, measuring about 12 inches in diameter and 7½ inches high.

Reed Electric Incubator.

The ease with which heat generated by electricity can be controlled thermostically has led many experimenters to turn to this agent as one offering a solution for the heating of an incubator. While the problem was apparently an easy one, few incubators were termed successful until the one invented and made by Lyman C. Reed, of the Electric Manufacturing Company of New Orleans, had been exhibited.

The Reed machine is constructed with double walls of galvanized steel filled in between with granulated cork. The doors open downward and the door jams cushioned to prevent leaks of air. The heating element is contained in the roof of the incubator and so designed that a uniformly even temperature is contained in all parts of the machine. The incubator operates from an ordinary lamp socket, and once connected and regulated, the temperature is automatically held at the temperature desired without further attention.

To electric light plants operating an all day and night circuit the electric incubator proves an additional source of revenue and adds another item to the list of current consuming devices helping to raise the load factor. Mr. Loring Brown of Smyrna, Ga., is sales agent for the State of Georgia, and can furnish other information to those interested.



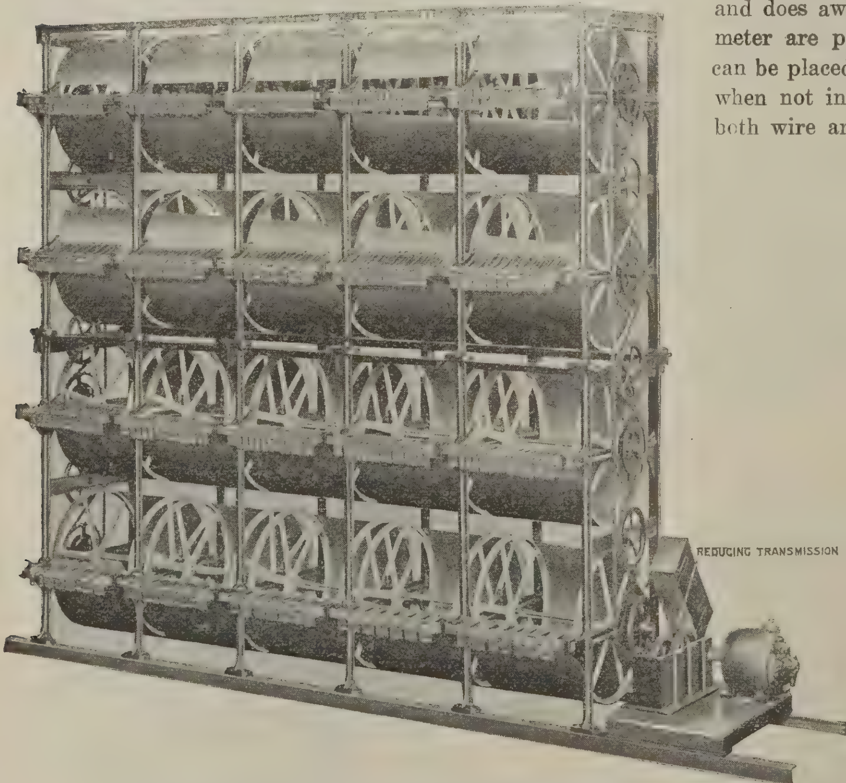
THE REED ELECTRIC INCUBATOR.

Front Flashing Equipment for St. Louis Hippodrome.

Talbots Hippodrome is a large and handsome new theatre in St. Louis. It is located at Sixth and Locust Streets, and is made conspicuous at night by a facade of lighting, of which the effect is similar to that which would be reproduced by an artist who made an outline sketch of the principal architectural features of the front of the building. This flashing of the spectacular outline lighting on the building front is accomplished by means of a lamp flasher of unusual interest, which is illustrated herewith. This mechanism, which is 6 feet high and 8 feet long, is one of the largest in service at the present time, and has 232 switches of various carrying capacities, operated on 18-inch drums. The arrangement is for 191 changes, and the total number of lamps controlled by this machine is about 8,000. The lighting load controlled is about 4,000 amperes at 10 volts, low-voltage Tungsten lamps being used. A 1/6 H. P., 110 volt direct-current motor drives the switching mechanism through a set of reducing gears, which reduce the speed of the armature shaft in the ratio of 2500 to 1. The Reynolds Electric Flasher Manufacturing Company, of Chicago and New York, was the maker of this interesting combination.

Fifty seconds is consumed in the operation of flashing the lamps on the entire theatre front. The flashing begins by first throwing into circuit the semi-circular cornice over the middle portion of the facade. The lamps come on one at a time in a similar manner to that observed in the script-writing effects often seen in electric signs. Other rows of lamps come on in the same manner, and light up in regular order various designs of the architectural ornamentation. The cornices and outlines on each side of the central portion next come into view, then the intervening sections and finally the window outlines, one at a time, until all the original features of the front of the building stand out in lines of light. As stated before, the effect is as though an artist had sketched in the principal outline of the facade, and the appearance is novel and striking. When the entire building front is outlined, the lamps burn for seventy seconds and then are extinguished in the order in which they were lighted.

Electrical energy at 110 volts, direct current, is obtained from the Union Electric Light & Power Co. By the use of a rotary converter, alternating current at 110 volts is obtained, and this is reduced to 10 volts through two large transformers. Tungsten lamps operated at this voltage are used for the spectacular lighting. The sockets were made by the Federal Electric Company and are set in copper troughs. The lamps are placed very close to one another, and when all the architectural features of the front of the building are outlined in light, the effect is very brilliant. The flashing scheme was worked out by Mr. Bert Volker, electrician for Talbot's Hippodrome, and the chief engineer for the Reynolds Electric Flasher Manufacturing Company. Including the flasher, rotary converter, transformers, wiring, cut-out blocks and lamps, complete, it represents an outlay of about $15,000.00.



FLASHER USED AT TALBOT'S HIPPODROME, ST. LOUIS, MO.

Wire Reel and Meter.

A useful and efficient device for measuring and reeling wire and cordage of various sizes has been placed on the market by the Minneapolis Electric & Construction Co., of Minneapolis, Minn. The construction of this device is shown in the illustration herewith and its usefulness to dealers and contractors handling electric wire will be readily seen.

In the meter the wire passes between two self-adjusting rollers, which admit of wide range, and will measure accurately large or small sizes, the pointers being movable and readily adjusted to the zero point. The reel is provided with removable cross bars, and the drum with grooves so the coil can be bound with tie wires and removed in a compact form. The meter shows the number of feet in the coil and does away with measuring on the floor. The reel and meter are portable and occupying small space, so that it can be placed where convenient for measuring and set aside when not in use. A meter can be secured for measuring both wire and cable as well as flexible conduit.

WIRE REEL AND METER.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

CORDOVA. The Cordova Light & Power Co. has applied for a franchise to supply electricity at Cordova. The parties interested in the company are J. M. Miller, G. S. Elliott, and E. G. Henton.

DEMOPOLIS. It has been announced that plans are complete for the construction of a cement manufacturing plant at Demopolis. The Alabama Portland Cement Co. plant at Stogart, Ala., has been bought by El Paso capitalists and will be remodeled.

HEFLIN. According to reports, W. O. Grant is contemplating the installation of an electric light plant.

MOBILE. An expenditure of approximately $20,000 has been authorized by the city council for improvements to the municipal water works. Electrically driven equipment will be installed.

MONTGOMERY. Sites for hydro-electric developments on the Coosa, Tallapoosa and Tennessee rivers in Alabama have been secured by a London syndicate. It is the purpose of the promoters to deliver electrical energy in Birmingham, Montgomery, and other cities in Alabama, and complete developments at various sites involving an expenditure of between twenty and thirty millions of dollars.

FLORIDA.

DE LAND. It is understood that the DeLand Electric Light, Power & Ice Co. will award a contract about February 11 for a 250 K. W. 60 cycle 3 phase 2300 volt generators direct connected to a four-valve engine. Information can be secured from the general manager, E. L. Hon.

FORT PIERCE. It is understood that D. D. & C. M. Rogers of Daytona, Fla., have been engaged by the city council to prepare plans for the electric light plant. Bonds to the extent of $15,000 have recently been voted for this purpose.

JACKSONVILLE. The Jacksonville Electric Co., it is reported, will lay double tracks on its riverside line on St. Johns Avenue in Jacksonville. The extension of the Hogan Street line to Enterprise Street is contemplated.

MADISON. The city has voted $30,000 in bonds for the purpose of purchasing the local light and water plant.

ST. AUGUSTINE. W. D. Barnett, of Jacksonville, Fla., has purchased the plant and holdings of the St. Johns Light & Power Co. According to reports, the company will remain under its present management but extensive improvements will be made to the plant and service.

TAMPA. The Tampa Electric Co. will increase its capital stock from $1,700,000 to $1,870,000.

GEORGIA.

ALBANY. The city council is considering the installation of an ornamental street lighting system in the business district.

AMERICUS. The city council has decided to call an election for the purpose of voting on an issue of bonds to the extent of $60,000. Proceeds to be used for the construction of a municipal electric light plant in connection with the waterworks.

ATLANTA. Upon second application to the State Railway Commission, the Georgia Railway & Power Co., formation of which was recently reported in these columns, have been granted its original request to authorize an issue of $27,000,000 in stock and $30,000,000 in bonds. With this authorization the company plans to push its works to an early completion and carry out its plan as previously outlined.

CUTHBERT. Plans are being prepared for the construction of an electric light plant. The issue and sale of bonds has been effected.

DOUGLAS. Installation of electric light and waterworks system in Douglas has been decided. Bonds to the amount of $15,000 have been voted.

ELBERTON. The Elberton & Eastern Railway Co. has secured the right of way and has awarded the contract for the construction work of a twenty-one mile electric railway from Elberton to Tignall. Contract has been secured by R. L. McCord of New York.

LAGRANGE. The Georgia Railway & Power Co. is reported to have purchased a site and water rights in the northern part of the city. The company proposes to erect a substation at this place from which it will supply local consumers. According to present plans, the development is to be constructed at Franklin near LaGrange.

MACON. The contract which has been under consideration between the city council and the Macon Railway & Light Co., has come to the point where the city council has authorized the mayor to sign the contract. This contract calls for lighting the streets of the city for a period of five years, to take effect from January 1st, 1912. Under the contract, the company agreed to furnish current for seven and a half ampere series arc lamps at $60 per year, 4 ampere magnetic arc lamps at $60 per year, 50 candle power series incandescent lamps at $24 per year, whiteway five lamp standards at $24 per year each, these posts being equipped with five 40 Mazda lamps to burn all night and every night. For the standard carrying five lamps of 40 watt Mazda, burning six hours, $13 each per year. In consideration of the low rates, the city agrees to install during the next year additional arc lamps, making a total of 400 street arc lamps, not including the ornamental system. It is also further agreed on the part of the company to supply electricity for lighting city buildings at 5 cents per k. w. hour and commercial lighting at 12 cents per k. w. hour, with discount ranging from 10 to 60 per cent according to consumption, and for motors at 10 cents per k. w. hour, with discount ranging from 10 to 60 per cent according to consumption and proper payment. The central station agrees to maintain lamps, wires and poles used in connection with the street lighting system, including the maintenance of lamps, globes, poles and conduit in connection with the whiteway, which is not the property of the company.

MANCHESTER. The city has decided to erect an electric light plant and has authorized an issue of $15,000 in bonds for the purpose.

MOULTRIE. J. W. Houstal & Co. desire bids on electrical wiring and fixtures for a $16,000 church building.

NEWNAN. The R. D. Cole Mfg. Co. will rebuild its plant for the manufacture of metal tanks. Cost will be approximately $15,000.

WASHINGTON. It is understood that the city has rejected bids for the construction of the power plant and improvements to the electric light and power transmission system as reported in the last issue of "Southern Electrician." New bids will be received until January 22nd, according to plans by Westinghouse, Church, Kerr & Co., engineers, at New York. Further information can be secured from the city clerk, Mr. D. Ficklen, Jr.

WAYCROSS. It is understood that W. M. Toomer of Jacksonville, Fla., is planning to build electric railway in the suburbs of Waycross. This line will be operated by the Waycross Electric Railway Co.

KENTUCKY.

CADIZ. The electric light plant to be built by the Alexander Bros. for which the franchise was recently secured, will be operated by water power.

ISLAND. The city of Island, now considering plans for the erection of an electric light plant, intends to receive the current from the Memphis Mining Co.

LEBANON. The Lebanon Light, Ice & Power Co. will build an ice plant of a capacity of 15 tons daily. The cost will be approximately $18,000 to $20,000.

LOUISVILLE. The Fossee Novelty Co. has been incorporated for $25,000 capital stock to manufacture electrical mechanical devices. Louis Fossee, E. A. Ryans and C. B. Mullins are the incorporators.

WARREN. The Brush Creek Mining & Mfg. Co. will install electric motors about March 1st. The general manager is R. L. Wheeler.

LOUISIANA.

DONALDSONVILLE. Geo. M. Borde, Consulting Engineer, has been employed by the town council to prepare plans for improvements to the municipal electric light and water-

works system. It is estimated that the cost will be approximately $30,000.

GALVEZ. Bonds have been voted for the construction of a municipal electric light plant at this place.

LAFAYETTE. The Southwestern Traction and Power Co., of New Orleans, La., will continue their plans to construct two light and power plants, traction lines, etc., from Lafayette to Berwick Bay. Further information can be secured from the president, S. W. Crosby, of New Iberia, La.

MITCHELLVILLE. The city has voted to grant a franchise to G. G. Gibson to install an electric light plant.

NEW ORLEANS. There is now under consideration by New York and European capitalists, plans for the development of hydro-electric resources of Louisiana for the purpose of generating electrical energy for transmission over an extensive system of transmission lines. It is also understood that a system of electric interurban railways through the central, western and southwestern parts of Louisiana will involve the expenditure of $10,000,000 to $25,000,000. It is understood that the company proposes to construct a plant that will allow transmitting and distributing electrical energy in New Orleans for electric lights and motors on the basis 8 to 10 cents per k. w. hour. Reports state that Henry Floy of 165 Broadway, New York City, is the consulting engineer.

VIVIAN. The Caldwell & Heath Electric Co., is considering the construction of a power house.

MISSISSIPPI.

JACKSON. Improvements are to be made to the system of the Jackson Railway & Light Co. It is estimated that the cost will be approximately $2,500.

MERIDIAN. Application has been made for a charter by the Meridian & Deepwater Railway Co. to build an electric railway between Meridian and Winona. The directors are B. Smith, Secretary and Treasurer.

NORTH CAROLINA.

ALBEMARLE. J. R. Ross of Albemarle, and associates, have asked the city council for a franchise to build a two mile electric railroad from Winston-Salem station and extending over several streets in Albemarle and out Maine Street to Crowell Mineral Springs.

BLEWITT FALLS. The Carolina Power & Light Co. are now nearing the completion of its hydro-electric power plant at Blewitt Falls. Current is to be transmitted to Fayetteville, Jonesboro, Raleigh and other points.

CHARLOTTE. Contracts have been awarded for several stations on the line of the Interurban Traction system in North and South Carolina. The stations will be located at Charlotte, Grenville, Anderson and Gastonia, and will be ready for operation about April 1st.

DURHAM. Arrangements are being made for the connection of the lighting system of Trinity College to the system of the Southern Power Co. If these arrangements are brought about, the lighting of the buildings of the college will be taken care of by this source and will relieve the old plant now operated in one of the buildings.

GOLDSBORO. The property and franchises of the Goldsboro Traction Co. have been purchased by the Goldsboro, Seven Springs and Swansboro Railway Co. This is a new company recently incorporated and said to be preparing plans for the immediate extension of a railway from Goldsboro to Seven Springs.

MAIDEN. The installation of an electric light system in Maiden is now under consideration. O. F. Asbury, of the American Machine & Mfg. Co., of Charlotte, N. C., is interested.

SHELBY. The city voted on December 5th, 1911, to issue bonds to the extent of $13,000 to take over the plant and holdings of the Shelby Electric Light Co.

WILMINGTON. It is understood that the Tidewater Power Co. will make extensive improvements to their plant, doubling the capacity of the power plant, and installing other equipment, at the approximate cost of $125,000. Plans are being prepared by Henry Torrence, Jr., 50 Church Street, New York City.

WINSTON-SALEM. The Blue Pearl Granite Co. is planning to move its plant and will install considerable additional machinery, including a crane, two motor polishing machines driven by twenty horse power motors, and also an air compressor, requiring a seventy-five horse power motor. About 100 horse power additional will be required for operating additional machinery.

OKLAHOMA.

HAMMON. Bonds to the amount of $21,000 were voted on December 20, the proceeds to be used for the installation of an electric light system. The Western Engineering Co., of Oklahoma City, has charge of the engineering work.

HOLDENVILLE. The consulting engineers for the city have submitted to the city commissioners a report involving extensions to the waterworks system and the installation of an electric light plant. The cost of the improvements will be approximately $24,000.

MULDROW. According to reports, the city is considering plans to effect the extension of the transmission lines of the Fort Smith Light & Traction Co., of Fort Smith, Ark., to Muldrow, and supply electricity for commercial purposes.

SOUTH CAROLINA.

AIKEN. The Carolina Light & Power Co., of Langley, S. C., report a property loss of about $35,000 through the carrying away by a flood recently of the dam and power plant. Service for the company is being rendered by an auxiliary plant at Horse Creek.

COLUMBIA. The Columbia Railway, Gas & Electric Co. is planning the construction of a dam across Columbia Canal and Saluda River. It is understood that the plan for the development is to construct a plant that will act as an auxiliary to the present equipment.

SPARTANBURG. Surveys are being made by the Spartanburg Railway, Gas & Electric Co. for an extension in Spartanburg, according to reports. S. H. Knox is general manager at Spartanburg.

SPRINGFIELD. The Springleld Electric Light & Power Co. has been incorporated with a capital stock of $20,000 by J. McVeen, President; Mike Cleason, Vice-President, and J. B. Smith, Secretary and reasurer.

TENNESSEE.

LEXINGTON. The city has approved a bond issue of $50,000 for the erection of an electric light plant and a system of waterworks.

NASHVILLE. The Great Falls Power Co., of Nashville, is preparing plans for a hydro-electric development on Kene Fork River. Work will begin on the plant which is designed to generate electrical energy for transmission to Nashville and the neighboring cities in Tennessee. F. N. Hughes is the superintendent of the company.

WOODBURY. The city is considering the installation of an electric light plant.

TEXAS.

BAIRD. The Baird Ice & Light Co. has been formed with a capital stock of $20,000. The incorporators are P. A. Hoover, W. W. Wedeborn and E. M. Smith.

BEEVILLE. The Beeville Mfg. Co. will open bids for the installation of a 2300, 60 cycle, 150 k. w. alternating current generator about February 1st.

CALVERT. The Calvert Water, Ice & Electric Light Co. has agreed to improve its water and light system with an expenditure of $14,000.

COLLINSVILLE. The Collinsville Mill & Elevator Co. is considering the installation of an electric light plant and waterworks system in Collinsville.

DECATUR. It is understood that the city has voted $18,000 in bonds for the purchase and repair of waterworks and electric light plant.

ELM FORK. Plans and specifications for the proposed dam on Elm Fork near Dallas for additional water supply for that city have been finished, and bids for construction will soon be called for. It is estimated that the dam will cost approximately $25,000.

BOOK REVIEWS.

DYNAMO, MOTOR AND SWITCHBOARD CIRCUITS FOR ELECTRICAL ENGINEERS, by William R. Bowker. Published by Crosby Lockwood and Son, London, D. Van Nostrand, American agents. Second edition revised and enlarged. 168 pages. 130 illustrations. Price, $2.50.

This work is designed from a practical standpoint, discussing in non-mathematical language the problems involved in direct and alternating current systems. The author has enjoyed a wide experience in construction, operation and maintenance of electrical systems in this country as well as abroad. This experience is reflected in the work as it presents in connection with every phase touched up, an intimate knowledge of the nature of perplexing questions and gives such clear and concise information in the form of circuit diagrams and explanatory descriptions, that we heartily recommend the work to all connected with systems of generation and distribution.

Section VII of the work will be found of particular interest to central station readers. This section is entirely new in the second edition and takes up testing and some of the problems met with in the combined lighting and railway station. The topics touched upon by sections are as follows: (1) Continuous Current Dynamos; (2) Direct Current Motors; (3) Two and Four Pole Shunt Motors and Auto-Starters; (4) Electric Traction; (5) Combined Lighting and Power Schemes; (6) Alternating and Polyphase Circuits; (7) Central and Power Station Layout and Operation.

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CONTENTS.

Transmission System of Southern Power Company.

When the name Southern Power Company comes to the mind of the average layman, the thought action in comprehending it, refers to a large commercial organization operating electrical machinery at a number of plants, sufficient to supply electrical energy over a wide district for a certain sum. How different in contrast is the average engineering conception of this far reaching public utility company of the South, with its station capacity of over 100,000 kilowatts and its transmission lines approaching 1,500 miles in length? How varied and complicated are the problems represented in the eight years of development from a single station of 6,600 kilowatt capacity to a system of interconnected stations of the capacity named? Certainly the imagination has plenty of chance to wander, for who can scan the history of high tension transmission during the past ten years, without falling into the numerous by-passes that were opened before a transmission line of 200 miles at 100,000 volts could be called a commercial proposition? How, we repeat, can these conditions be imagined without fully comprehending the enormity of the engineering problems and the monument to early high tension transmission that the Southern Power Company is and stands to commemorate?

The article presented elsewhere in this issue by Mr. J. W. Fraser, Assistant Chief Engineer of the Southern Power Company, and the Steinmetz of the South, calls to mind most clearly and emphatically the development of high tension transmission. Most particularly, however, does it review the features both physical and electrical upon which the success of the above company's system has been based, It has been said that there are two kinds of conservatism in electrical design. One departs not in the least from existing plans or equipment while the other adopts no particular circumscribed course but makes use of apparatus only after its success can be absolutely assured. Far be it from our intention to classify the engineering policy of the Southern Power Company by the above definitions, yet it is within our province to suggest that the results of the system's operation, points to a course of procedure in design midway between the limits set by these definitions, making up a policy of conservatism which would be expressed as follows: No departure is made from plans that have been found successful and all modern schemes of construction are made use of according to the degree in which they are applicable to existing conditions.

Electrical practice is now pointing decidedly toward a necessity for centralization of power generating facilities. Large and small quantities of energy must now upon request for same, be delivered over longer distances and throughout wider areas, thus forcing the small and inefficient station to call for help by consolidating and becoming a part of a larger and more economical assemblage of equipment. While the Southern Power Company has foreseen these conditions among the first and has developed an extensive system, its work is not finished. Its power load

has not yet reached much more than a good start toward the utimate load for which equipment must be in readiness to carry at the end of the next five years, judging from the rate that the various industries have been expanding and springing into existence during the immediate past.

Turning from the general to the more specific, it must be noticed in reading Mr. Fraser's description of the transmission system now operating, that there are features which may be peculiar to Southern conditions, yet even so deserve consideration for other localities. We refer to the success of outdoor substations, circuit breakers and lightning arresters for voltages from 40,000 to 100,000. Mr. Fraser is an ardent advocate of this arrangement as well as high line insulation, the use of ground wires for protection against lightning, and earth foundations for towers as opposed to concrete. The results of such arrangement seem to amply vindicate his judgment and point to a closer investigation of the operating limitations. While these features may have seemed at one time radical and so largely experimental as to fall only to those companies equipped to financially stand the speculative nature of the results, they now take on a distinctly different aspect and too little recognition is given to the initiative that backed it all up. Another feature which must not be overlooked is the line switching arrangements. With a growing system where additions and improvements of various natures are constantly taking place, where there are eight generating stations, over 1,300 miles of transmission line and 75 distributing substations, with 156 mills, six street car systems, and the lighting and power requirements of 45 towns and villages depending upon them for supply, this problem presents itself in tremendous proportions. The situation has, however, been squarely met and with the proper sectionalizing of lines at certain points and reliability of apparatus looked after, expanding conditions and demands have been successfully cared for.

Reflectors and Light Distribution.

Thanks to the rapid progress which has been made during the last few years in scientific illumination, since exact data is now obtainable for the distribution of light not only from the lamps themselves but also from the lighting units taken as a whole. That is the lamps as aided and modified in their effect by the reflectors, shades or globes used with them. In practice, it is the unit as a whole that gives us the lighting effects by which the consumer profits and for which he has to pay, hence it is from this general effect that he must judge what he is getting. What this will be, may be estimated to some extent from the rules which have already been determined as to the shaping of globes and reflectors when made of certain materials, but the moment we vary the materials, the rules no longer hold and new rules or their equivalent in some form or other must be determined for the shades made of the new materials.

This has been particularly noticeable of late in connection with the growing tendency toward departing from the old imitation glass effects, in place of which prominent arcihtects as well as engineers are beginning to adopt glass ware made of a proper design, which will readily lend itself to artistic effects. When such ware is offered to those seriously looking into the problem of economical lighting, two questions are commonly raised by architects as well as shrewd consumers of light. First, does the change to the newer and as many think, more lucidly artistic, materials mean a loss of light? Second, can a reasonably uniform distribution of the light be obtained by using artistically shaped reflectors made of proper materials?

As to the first question, all tests so far reported agree that the loss of light by absorption is quite small in all new designs including the pearly materials when these are free from specks or cloudy spots which would interfere with the free passage of the light. Moreover, the smooth surface, free from horizontal ribbing, does not afford the lodging places for dust which have made some of the cut glass types of clear shades difficult to clean. This deposit of dust must be taken into consideration in making any comparisons between the classes of reflectors and shades if such comparisons are to have a commercial value.

As to the second question, curves of light distribution have already been furnished by numerous manufacturers for a variety of shapes but usually these are in the form of bat-wing or butterfly curves which do not convey much meaning to the men who must pay for the light or who must satisfy the user of light that he is getting good value for his money. What these people want to know is, whether or not the use of glassware made of the newer materials will allow them to distribute the light widely and evenly. And just what features are to be sought for in getting the greatest amount of useful light out of energy consumed by the lamp.

To See Ourselves as Others See Us.

By the absorption of the *Electrical Age*, now something over a year ago, SOUTHERN ELECTRICIAN through the combination became one of the oldest electrical journals, making it now nearly 30 years of age. The activity of SOUTHERN ELECTRICIAN in the South particularly, however, dates back with this issue six years and two months. In this our distinct field, we have developed so fast, in endeavoring to keep pace with and truly represent the electrical development of the South, that we have outgrown our clothes, so to speak. It is quite necessary that this condition be remedied immediately, and to see ourselves as others see us, we are asking our readers to advise where to apply the cloth to the best advantage. We are very well informed as to how well we look and how well we have done. What is most desired are those things we have not done and should do It is therefore, with all sincerity that you are asked, Mr. Reader, to privately tell us in what way SOUTHERN ELECTRICIAN can be of greater assistance to you in your business or in your profession. The management and editorial staff naturally feel proud of past accomplishment, however, if we have been too liberal in any assumptions in this direction, you are urged to speak the truth as you alone know it.

In order to accomplish the object sought, we have decided to distribute among our readers $100 in cash for the best letters contributed and in the following manner: We will pay $50 for the best letter criticising SOUTHERN ELECTRICIAN from any standpoint, or the letter may be a suggestion for improvement. It may discuss any subject of interest to the electrical industry from the viewpoint of the electrical engineer, the architect, the central station, or the contractor; such as particular features of development, electrical trade conditions, problems for future solution, etc. Take your choice of the subject. For the second best letter on any of the above subjects, we will pay $25. For the three next best, $15, $5 and $5 respectively. The conditions under which all letters must be written are given on page 62 of this issue.

NINETY-NINE ISLANDS GENERATING STATION OF THE SOUTHERN POWER COMPANY.

The Southern Power Company's Transmission System.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)
BY J. W. FRASER, ASSISTANT CHIEF ENGINEER OF SOUTHERN POWER COMPANY.

IN view of the fact that the Southern Power Company represents the largest electrical generating and distributing system in the South, and a company that has taken an active part in the history making of successful long distance transmission, the details of the developments and the physical and electrical conditions which have made their successes possible will be of interest. We are particularly fortunate in being able to draw directly from a member of the original engineering staff of the above company and one who has passed through and been largely responsible for the developments. Mr. J. W. Fraser has originated not a few departures from what seemed at the time natural tendencies in high tension transmission. To him largely therefore is the credit due for the successful working out of the many complicated problems involved in giving to the South a system of inter-connected generating stations of an aggregate capacity of over 100,000 kilowatts and a net work of radiating high tension lines measuring over 1,300 miles. This article has been prepared with the assistance of Mr. Frazer from an exhaustive paper presented by him last November before the Canadian Society of Civil Engineers. The information presented herewith gives those engineering features in connection with construction and operation of the system's lines in such detail and careful consideration of vital points as is characteristic of the author's engineering work in general.—EDITOR.

FIG. 2. INSIDE OF 99 ISLANDS STATION.

In order to convey an intelligent impression of certain features of the transmission system of the Southern Power Company it will be necessary to refer briefly to the history of transmission in America, and to that of the Southern Power Company, and of the Catawba Power Company. It must be remembered that even eleven years ago, when the latter company was organized, electric transmission was not in the advanced condition that it is today, but it hardly seems credible that when the Southern Power Company was organized, in 1905, one of the foremost engineers of the day voiced the opinion that 33,000 volts was preferable to 50,000 volts.

The first electric trasmission in America was installed at Telluride, Colorado, in the summer of 1890, a 100 H. P. single phase generator supplying power at 3,000 volts over a line two miles in length to a 100 H. P. synchronous motor. In 1893, the first polyphase transmission was put into service at Redlands, California. This was three-phase, 2,500 volts, eight miles in legth. The decision, in the same year, to make the generators at Niagara Falls polyphase, instead of direct current, marks an epoch in transmission history. The Folsom-Sacramento plant in California, the first polyphase transmission at 10,000 volts, was put into operation in 1895. In Canada the first polyphase transmission seems to have been at St. Hyacinthe, Quebec, in 1894. Development proceeded rapidly in the next few years and comparaitvely large plants were installed at several places. The Missouri River Power plant was the first to operate commercially at 50,000 volts, and the Shawinigan transmission to Montreal was put into service a few months later.

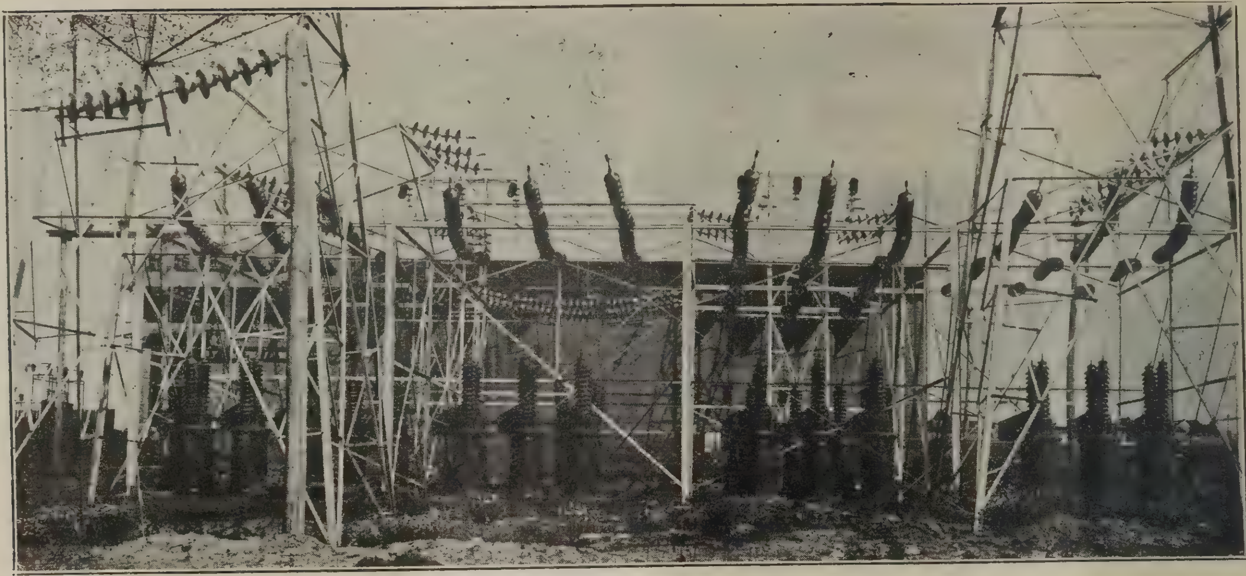


Fig. 3. Outside Switching Station on 100,000 Volts.

What may be considered the first electric transmission in the South was at Anderson, S. C., in 1895, when 175 H. P. was transmitted from the Rocky River to Anderson, a distance of eight miles, at 5,500 volts. Three years later 1,200 K. W. was transmitted from Portman Shoals to Anderson, a distance of ten miles, at 11,000 volts, and here the first 11,000 volt generators ever used in commercial service were put into operation. The next step was to increase the size of developments. A 10,000 H. P. plant was commenced, in 1900, on the Catawba River, near Rock Hill, and completed in the spring of 1904. 13,000 volt generators were used directly on the transmission lines to Rock Hill, six miles, to Charlotte, eighteen miles, and to Clover, twenty-three miles. In 1905, the Southern Power Company was organized for the purpose of taking over the above plant and developing certain water powers on the Catawba and Broad Rivers. The plant was put into operation as follows: Great Falls, of 24,000 K. W. capacity with two hundred miles of 50,000 volt line, was put into service in the early spring of 1907; Rocky Creek of the same capacity as Great Falls, with as much additional 50,000 volt line, was completed in the spring of 1909; and Ninety-Nine Islands, with a capacity of 18,000 K. W., was completed in the spring of 1910. In the autumn of 1909, a 100,000 volt line of 250 miles was put in service, and since that time a second circuit has been strung on these towers and 140 additional miles of two circuit 100,000 volt line completed, a total of 1,380 miles of three-phase line. Simultaneously with the growth of line there were built twenty-five 10,000 volt, thirty-two 50,000 volt, and eighteen 100,000 volt substations, ranging in size from 300 K. W. to 28,000 K. W. and secondary voltages of 550, 2,200, 11,000, and 44,000. Within the last year two 8,000 K. V. A. auxiliary steam turbine stations have been added to the generating plant, and one 2,600 K. W. hydro-electric station purchased. A greater part of this power is used by cotton mills of various sizes to the number of 156, the remaining power supplying six street car systems and the lighting and power load of 45 towns and villages.

The accompanying map of the transmission system shows how scattered the market of the Southern Power Company is. Charlotte, fifty miles from Great Falls, with a population of about 40,000, is the largest town reached. Taking this as a center, mill villages and towns of all sizes, varying from 1,000 to 30,000 inhabitants, extend along the Southern Railway northeasterly to Durham and southwesterly to Greenville. To transmit the power from Great Falls over this district, a steel tower trunk line was built to Catawba station. This tower line was extended in a westerly direction to Gastonia, and double wood pole lines were built in a northerly direction to Charlotte.

STEEL TOWER TRUNK LINE.

The tower was designed for 2 circuits of 3-0 copper. The line towers were constructed for 1,000 pounds per pin and

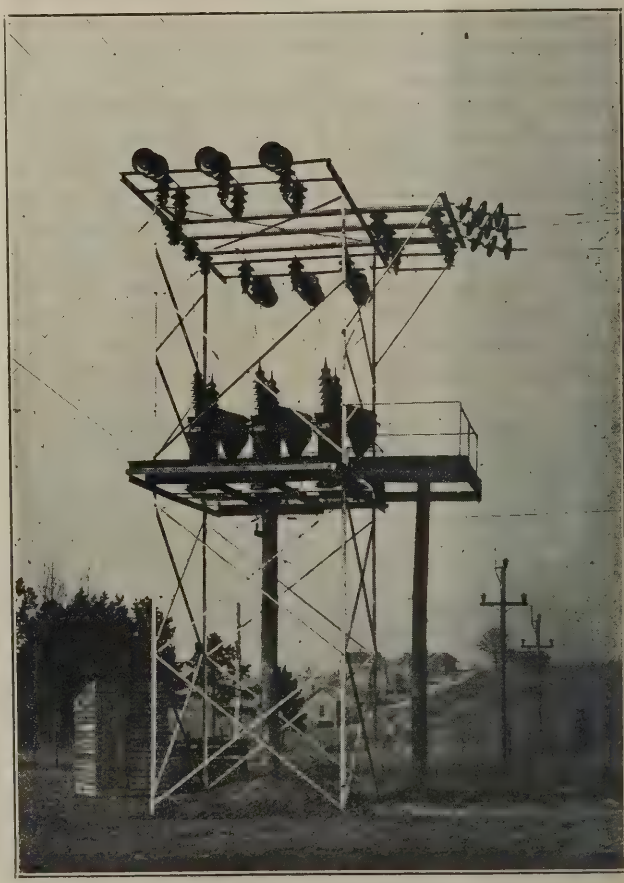


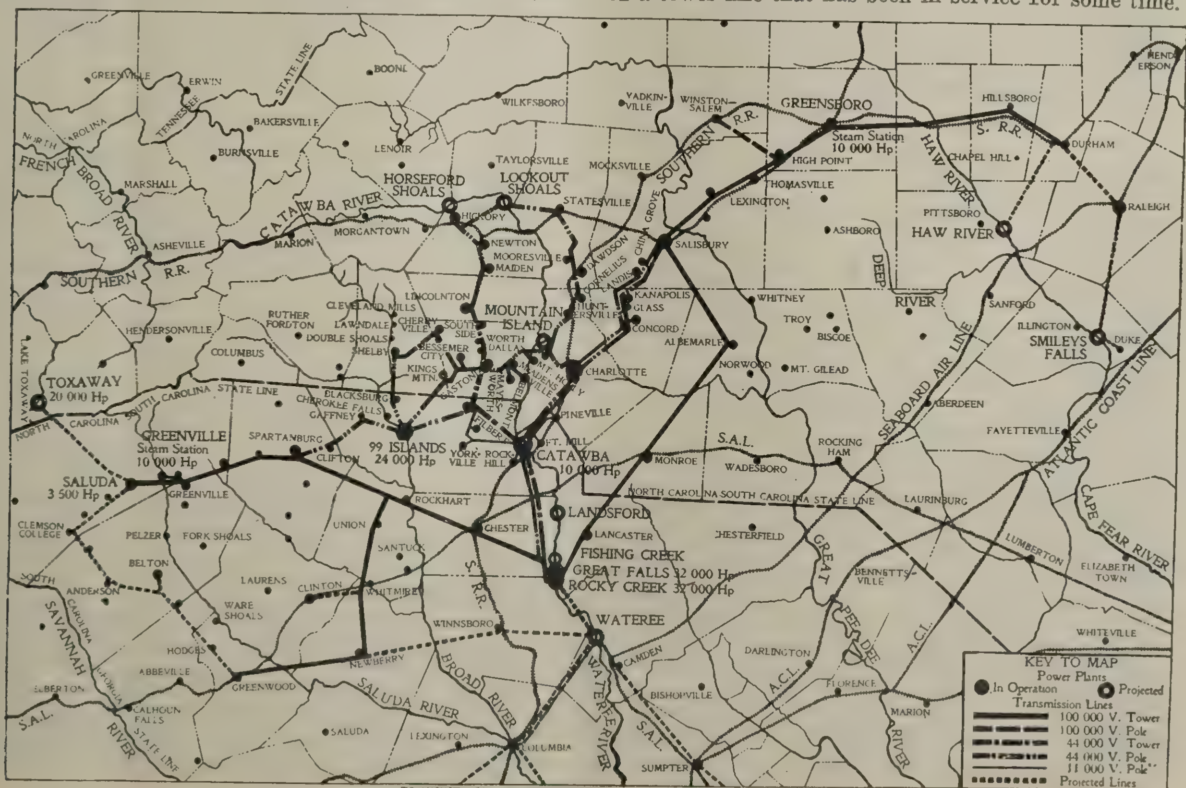
Fig. 4. Showing 50,000 Volt Outdoor Switches.

FIG. 5. A 100,000 VOLT SUBSTATION AND SWITCHING TOWER.

FIG. 6. THE SPARTANBURG STATION.

10,000 pounds breast pull. Heavy strain towers for 3,000 pounds per pin were used about every three miles and at angles. The conductor was stretched to about 2,500 pounds at 0 degrees Fah. (about 20,000 pounds per square inch), and dead-ended on three insulators in line. The intention was to use line tower clamps that would slip in case of breakage of conductors at about 500 pounds, but through error these clamps were made too small and tie wires were substituted. Trouble has been experienced on this line, due to the line current following lighting discharge from conductor to cross-arm and burning out the conductor. In some cases the towers were not damaged, but in many instances the cross-arms on towers adjoining the break were pulled off. The trouble was due to insufficient insulation—that is, the distance between conductor and steel cross-arm was insufficient to prevent flash-overs. In no case has an insulator been punctured, except when absolutely shattered by lightning. The insulators were three petticoated porcelain, with 12 inch head and 13 inches in height. On test they flashed over at about 125,000 volts, and under a spray of 1¼ inches of water per five minutes, at about 90,000 volts. They have been in service on several hundred miles of wood pole line for five years and have given excellent results, no insulator breaking down, except in lightning storms. In 1909, the number of insulators broken down on over 400 miles of line was thirteen.

The material used on standard 50,000 volt wood pole line is as follows: 35 feet 8 inches top chestnut poles, spaced 150 feet apart, with 4¾ inches by 5¾ inches by 72 inches cross-arms of 75 per cent heart pine, dipped in hot carbolineum or creosote, 2 inches by 2 inches by ⅛ inch galvanized cross-arm braces, ¾ inch through bolts and Lee iron pins. The top insulator is carried on a short cross-arm or iron bracket, which also furnishes a brace for pipe that supports ground wire. The ground wire is made of No. 4 B. B. galvanized iron wire and is grounded at every pole to a galvanized piece of sheet iron 12 inches by 12 inches stabled to the butt of the pole. Special heavy construction has been used on dead ends and turning angles. In describing the 100,000 volt lines the tower design will be taken up in some detail, for although it is evident that the assumptions made as to wind and ice load in one district may be totally inadequate for another, still in view of the wide variation of tower strengths called for in specifications sent to tower manufacturers, it may be interesting to know something of a tower line that has been in service for some time.



MAP OF SOUTHERN POWER COMPANY'S TRANSMISSION SYSTEM.

TOWERS FOR 100,000 VOLT LINES.

The wind strain on a 600 foot span of 6 conductors of No. 2-0 copper and a ground wire is 2,600 pounds, where 15 pounds is taken as the pressure of a 100 mile wind on a cylindrical surface (recorded velocity of wind referred to and not corrected velocity). The wind pressure on tower is 3,000 pounds ,where 30 pounds is taken as wind pressure on flat surface at the same wind velocity, and the area of the tower is 100 square feet. This area of tower is made up of the area of one side of the tower plus ½ of other side plus 10 square feet for insulators. The total wind pressure, therefore, on a 600 foot span is 5,600 pounds when the wind is blowing at right angles to line.

The Southern Power Company's specifications for suspension towers are drawn to cover: (1) A wind of 6,000 pounds at right angles to line and a simultaneous conductor strain of 2,500 pounds on any two cross-arms. (2) A vertical load of 1,200 pounds on the end of any cross-arm. (3) A load of 1,500 pounds in any direction on ground wire support. No allowance was made for a wind of 100 miles per hour on ice covered conductor and the simultaneous breaking of two wires, but the combined pull first specified is assurance that the tower will stand a wind of 100 miles per hour with ½-inch of ice, providing no wires break, or, on the other hand, the breaking of all wires without wind. On test the towers stood 6,000 pounds on cross-arms at right angles to conductor and 6,700 pounds on the same end of the three cross-arms in the direction of the conductor.

After the erection of this line the conductors have been sawed in two without any damage to towers. The weight of suspension tower is 3,600 pounds. The strain towers were designed for and withstood: (1) A torsional load of 3,000 pounds on one end of each of the three cross-arms, or a total of 9,000 pounds. (2) 3,000 pounds on each end of all cross-arms, or a total of 18,000 pounds. (3) A vertical load of 2,500 pounds on the end of any cross-arm. (4) A load of 2,000 pounds in any direction on ground wire support.

When the towers for the 100,000 volt line were being designed, 2-0 B. & S. (see foot note) copper was decided upon as the conductor and 600 feet as the most economical span. The following assumptions were made:—That the temperature would lie between 0 and 110 degrees F.; that the wind would not exceed one hundred miles per hour (recorded) and that the ice load would never exceed ⅜-inch. For the first 250 miles of circuit, hard drawn 7 strand copper with an ultimate strength varying from 55,000 to 60,000 pounds per square inch was purchased. This was to be pulled up to a trifle over 17,000 pounds per square inch, or 1,800 pounds for 00 B. & S. gauge at 0 degrees Fah. Area of copper, 0.105 square inches, weight per foot 0.403 with ⅜-inch

NOTE.—A short calculation will show that No. 0 will take about 3 feet more tower than No. 00 with the copper stretched to one-half the elastic limit with ice at 0 deg. Fah., and that if clearance must be maintained with ice on wire the additional cost of the larger size of wire is less than the cost of the additional height in tower. This is a good argument for using a larger wire, as it will carry 25 per cent. more with the same loss. If the choice had been between No. 1 and No. 0 this calculation would show that it would be cheaper to use the No. 0 wire than the No. 1 on account of this additional height of tower necessary to give the proper clearance when there was sleet on the wires.

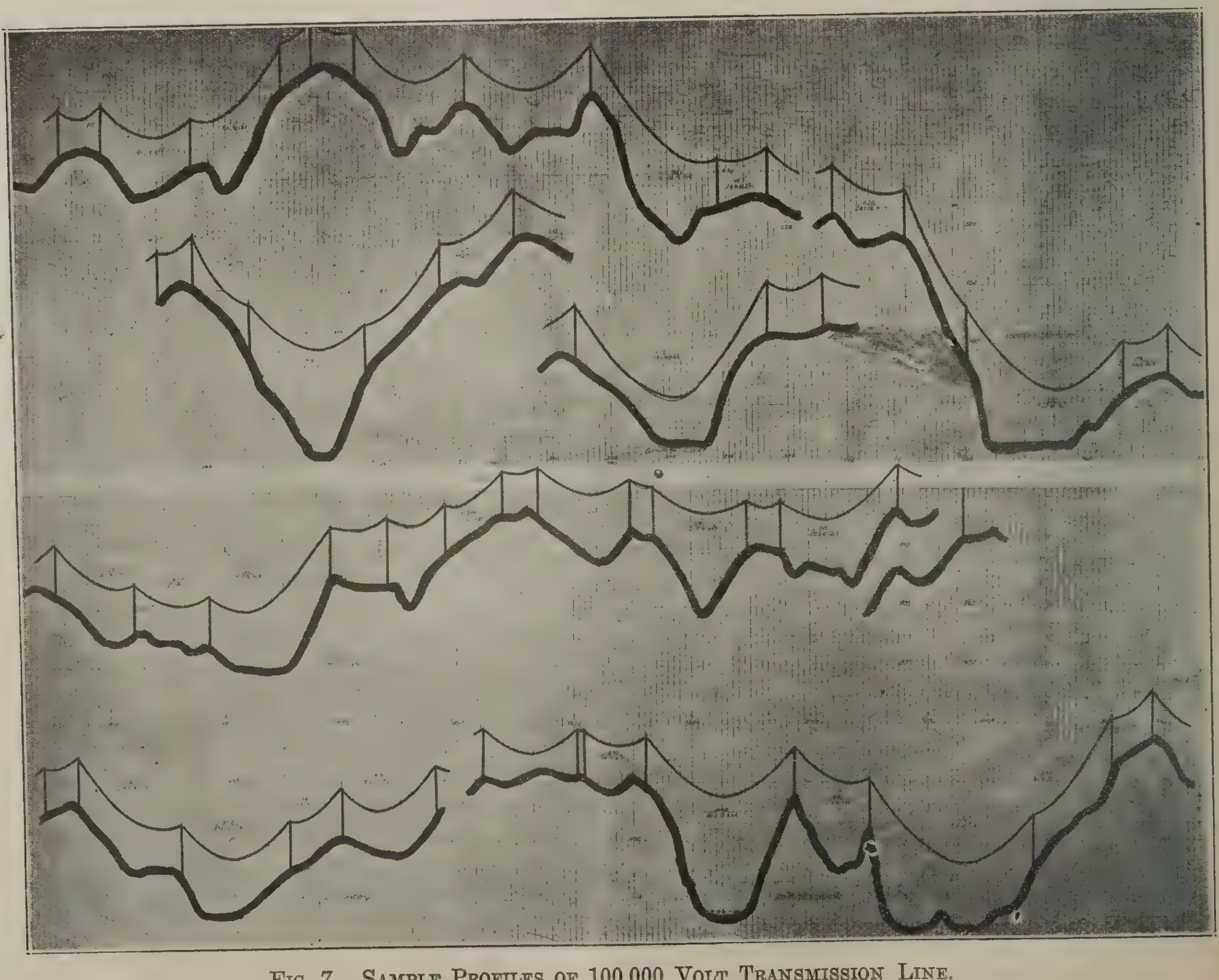


FIG. 7. SAMPLE PROFILES OF 100,000 VOLT TRANSMISSION LINE.

ice 0.8 pounds. Diameter of strand 0.5-inch (nearly). The sag for a No. 2-0 copper wire stressed to 1,800 pounds on a 600 foot span is about 10 feet, and with a rise in temperature of 110 degrees Fah. the sag will not be over 15 feet. In hottest weather a clearance of 25 feet between lowest conductor and ground was considered sufficient, and in as much as sleet is very rare, the height of the lowest cross-arm was determined upon as 44 feet on the above basis, assuming further that the height of insulators and clamp would not exceed four feet. Height between cross-arms was made 10 feet 4 inches, so as to provide for additional insulation if found advisable. The distance between insulator supports and the body of tower was made 6 feet 8 inches, to give ample clearance for swinging in wind storms. The weight of strain towers was 4,500 pounds. These towers have been subjected to one of the heaviest sleet storms in that district without damage.

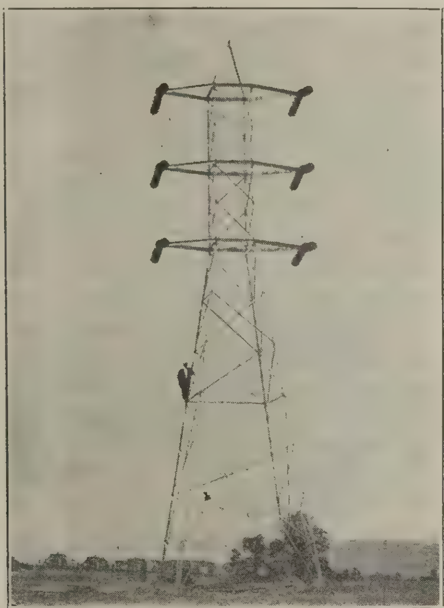


FIG. 8. A 100,000 VOLT TOWER.

One strain tower is used for turning angles of 45 degrees or less, by bisecting the angle with the centre line of tower. For larger angles two towers are used. Strain towers are also used on spans 750 feet and over. On street corners angles of 90 degrees are turned by placing three cross-arms at right angles to the regular cross-arms on the city poles and by using a small amount of special work to hold one set of wires away from body of tower. Extensions twelve feet in height are used on all towers where the profile of the land demands extra height. For the sake of convenience hooks instead of clevises fasten insulators to towers, and have been found entirely satisfactory. On the last 500 miles of 100,000 volt circuit aluminum conductor has been used three U shaped shields totalling 129 inches in length fastened around conductor at suspension supports.

ANCHORS.

Concrete anchors are not used on towers except in special cases when the soil is not firm or when large angles are to be turned. For the suspension towers a 12-inch channel, 30 inches long, fastened to the end of a 3½ x 3½ x ¼ angle, 6 feet long, is tamped well in the ground, and for strain towers a tripod anchor is used, extending 8 feet into the ground. This tripod anchor prevents the tower legs, which have no struts at ground elevation, from bending when the tower is under torsional stress. When turning large angles the anchor holes are filled with rock and if the earth is soft the rock is grouted with cement.

The suspension insulators have a diameter of 14 inches for the outer shell and 7 inches for the inner shell. Hooks and eyes were selected for connecting insulators together merely because of simplicity. Hooks were readily made to stand over 10,000 pounds in tension. The mechanical test on insulators was 8,000 pounds tension, but in some cases these tests have run over 12,000 pounds. Four insulators were used on suspension towers and five on strain towers. On one line a single 10-inch disk has been installed; six of these are used on suspension, and seven on strain towers.

As no suspension clamp that seemed satisfactory was on the market the one shown in Fig. 14 was designed. The upper part of this clamp has a hole sufficiently large to swing free on the hook of the insulator. The lower part has a groove, the bottom of which is shaped to fit the slope of the conductor. When the conductor is adjusted so that the insulator hangs vertically, the clamping piece is dropped in over the conductor and the two bolts pulled up, causing a wedging action, which clamps the conductor as tightly as desired. The groove and wedge are so shaped at the ends that if the conductor should break in any span the clamps would not kink the wire. The terminal clamps, which were also of home make, are very similar to a large three-bolt guy clamp with only one groove and a clevis at one end to slip over the hook on the insulators. Both clamps have proved entirely satisfactory.

SWITCHING LAYOUTS.

The switching lay-out has demanded more time perhaps than any other engineering problem. While a system is growing and improvements in electrical apparatus are being installed, it is impossible to make full provision for future requirements, and changes must be made as new plants and lines are added. In other words, the switching problem is naturally an evolution. This refers particularly to the high tension switching, but a word first about the low tension switching.

FIG. 9. NEWBERRY TRANSFORMER AND SWITCHING STATIONS.

At the Great Falls, Rocky Creek and Ninety-Nine Islands power houses and at the three others under design a great many layouts have been made, but the single bus, or the same general scheme as used at Great Falls has always been reverted to. At the Great Falls station there are four (6,000 K. W.) units, each consisting of two water wheels, two generators and three transformers, one low and one high tension bus bar and four circuit breakers

for outgoing lines. Each unit can be connected on either high or low tension side to the adjacent unit. In operation only the line feeder circuit breakers are automatic, and the high tension bus can be used as a transfer bus if necessary, or otherwise one unit can be made to feed its own transmission line separately by opening the oil switch connecting it to the transfer bus. Rocky Creek is identical with Great Falls as far as the 50,000 volt bus. The ends of the U bus are connected through automatic circuit breakers to the ends of the U bus at Great Falls, forming a ring bus, which facilitates the handling of the output of both stations over the Great Falls feeders to the transmission lines and 100,000 volt step-up transformer stations.

In regard to high tension line switching, on account of long distances to transmit over, it was necessary to lay out, first, the lines for the allowable drop in E. M. F., or economical loss under normal load and with regard to probable abnormal conditions caused by failure of any links in the system, and then lay out the switching that seemed to fit best with these conditions—making changes as experience was gained and unexpected loads were taken on. It is very obvious that this is a rather complicated problem, as there are eight generating stations, over 1,300 miles of high tension line and 75 distributing sub-stations feeding over 150 mills and many towns, small and large. All delivery points could not receive the same consideration.

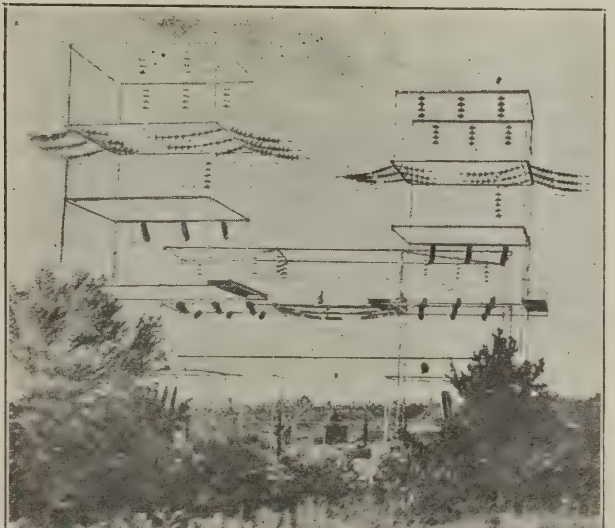


FIG. 10. TAP TOWERS ON 100,000 VOLT LINE.

Moreover, the further a customer is from the generating plant, the more numerous must be the ways of supplying him, and as the steam plants of customers using secondary power might sometimes be made available for emergency use, this also had to be provided for. Furthermore, the reliability of the apparatus had to receive due attention.

The magnitude of the problem is further emphasized by the fact that the cost of all switching apparatus on the system, together with the buildings that contain them, or the towers and poles on which to mount them, would probably approach 10 per cent of the cost of the entire system, including dams, lines and substations, and could easily be made to exceed this amount. It was obvious from the beginning that the sectionalizing of lines at certain points would be useful, allowing the cutting out of damaged sections and the parallel operation of the remaining section, but where to set the limit was not so obvious. The cost of sectionalizing at each point of delivery would be prohibitive, and where there were long lines without substations, an attendant would be almost indispensable.

At tie-in stations where there were many lines, some of which in emergency would be changed from feeders to receivers, the switching problem would become formidable if all combinations were to be made. The greater the number of lines coming together at one point, the more complicated becomes the switching problem, for the number of combinations possible increases more rapidly than in direct ratio. It would be a comparatively easy matter to lay out a switching scheme so that all combinations of lines could be made, but such a scheme might prove more cumbersome than useful. The subject became further complicated by the question as to when air disconnecting switches could be used and when it would be necessary to use oil switches or circuit breakers and disconnecting switches to cut them out. Up to two years ago no high voltage outdoor oil switches were on the market and buildings had to be provided where oil switches were used.

The writer will make no attempt to describe in detail the entire switching scheme, but will call attention to a few specific cases. Catawba, Charlotte, Concord, Salisbury and Gastonia are the main switching stations on the 50,000 volt lines. These and the intermediate points are fed from double circuits. Charlotte being a centre of distribution, the two incoming lines, the tie to Gastonia and the four outgoing lines have oil switches and bomb fuses connected with one bus in which there are oil sectionalizing switches. Gastonia is provided with oil switches and bomb fuses connecting to two bus bars. At Concord the switching station is similar to that in Charlotte. Most of the remaining points can be fed from either end of a loop circuit. On loop circuits oil switches are placed on either side of tap to station so that station can be changed to either end without interruption. Outdoor oil circuit breakers have been installed within the last year at some important tap-off points where there are no stations. Disconnecting switches are provided on either side of all oil switches.

On the 50,000 volt three circuit trunk line, 33 miles in length, from Great Falls to Catawba, automatic overload circuit breakers have been installed at either end, and sectionalizing air-switches with cross-over switches have been installed at two intermediate points of transposition. Reverse current relays have been tried on this line, but they have never proved of much service in disconnecting a damaged line. The cross-over switches have proved very valuable. The main switching points on the 100,000 volt lines are at Salisbury, Greensboro, Spartanburg, Newbury and Greenville, 93 and 150 miles in one direction, 65, 84 and 100 miles, respectively, in the other direction. At each of these points both lines can be paralleled or sectionalized. One left or right-hand circuit coming in can be crossed over on the right or left circuit going out, but it was not considered necessary to cross either circuit at the same time. At Salisbury and Spartanburg the 100,000 volt lines are tied-into the old 50,000 volt lines (See map for Salisbury wiring diagram). Greensboro is identical with Salisbury, except that tie-in is made through three 3,000 K. V. A. transformers to 13,000 volt lines, feeding mills in that district and to 8,000 K. W. steam stations from the tie-in between right and left hand cir-

cuits. There is also a tap to the three-1,000 K. V. A. transformers, which supply power to the local railway and lighting company at Greensboro.

From High Point the Winston-Salem 100,000 volt pole line taps off from either right or left-hand line through outdoor oil circuit breakers. It was on this line that the first 100,000 volt out-door circuit breakers ever built were put in service in the spring of 1910. On all 100,000 volt lines where sub-stations are within two or three miles of the main line, outdoor interlocking circuit breakers are arranged so that stations can be fed from either line. By removing interlocking device and closing both switches the main line is thrown in parallel. By opening both circuit breakers and the proper disconnecting switches and then closing both circuit breakers a cross-over can be made in case of a damaged line.

Wherever taps from both circuits are made on the main 100,000 volt tower line a special square tower is inserted in each line—one tower placed a few feet in front of the other. On these tap-off towers the three wires on each circuit are brought to a horizontal plane in order to facilitate bringing one line under or over the other. Disconnecting switches are inserted in both ends of the main lines attached to these towers. The taps to sub-stations are dead-ended on a twin tower under which is erected the outdoor oil circuit breakers. Either of these circuit breakers can be cut out with disconnecting switches which are provided for on the towers.

TRANSFORMER CONNECTIONS.

Many of the transformers in the 50,000 small transformer stations are protected by bomb fuses which are in series with oil switches, but all the 100,000 volt and the 50,000 volt transformer stations recently built have automatic circuit breakers. The 11,000 and 50,000 transformers are all delta to delta connected. When the 100,000 volt system was proposed, the engineers of the manufacturing companies preferred star connection on the high tension side, and the engineers of the Southern Power Company felt that it was desirable to take advantage of the less line insulation required on a star grounded system, but they were loath to give up the advantage of a delta connection on the sub-station transformers. After consideration it was decided to compromise by using star connected transformers in generating and tie-in stations, and delta connected on sub-station transformers.

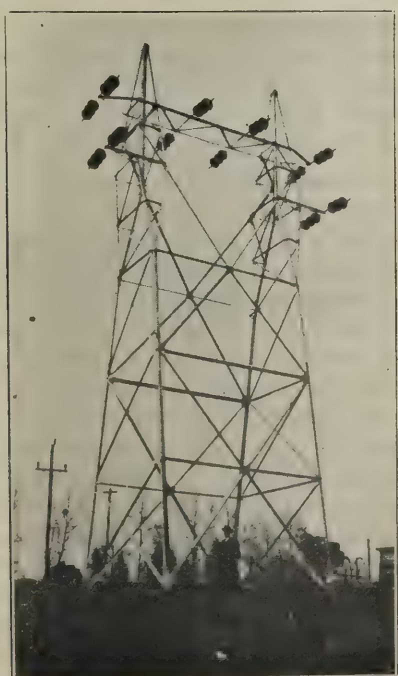


FIG. 11. STRAIN TOWER ON 50,000 VOLT LINE.

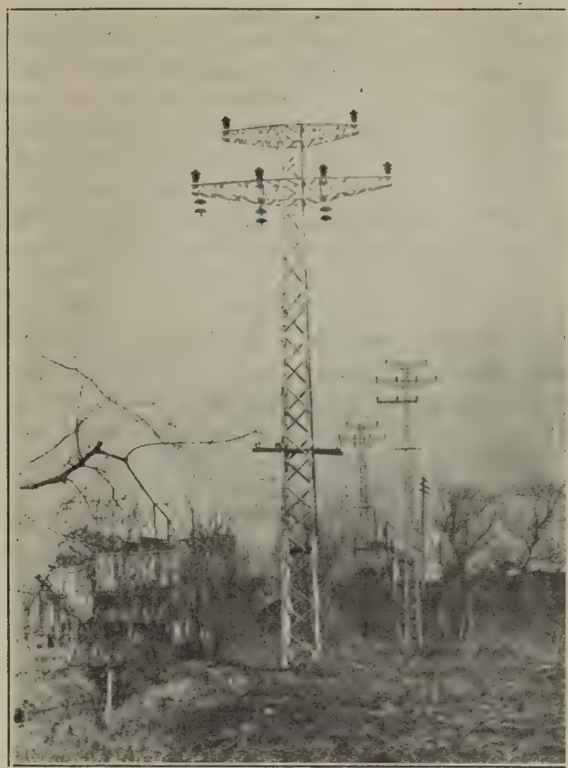


FIG. 12. CITY POLE WITH EXTRA LINE ON SUSPENSION INSULATORS.

So far only transformers of generating stations have been grounded. An iron grid resistance of 112 ohms with a capacity of 130 ampere seconds was ordered, but as it did not arrive when the line was ready for service, the neutral was dead grounded, and it has remained that way up to the present time without any injurious results. The tie-in transformers have never been grounded. It was feared that if star connected transformers were used at both generating and distributing stations, currents going between neutrals might affect adjacent telephone and telegraph lines by leakage across insulators on telephone lines. With the method adopted, that is, a star grounded connection on generating transformers, no trouble has been experienced on telephone or telegraph lines.

There are now in operation on the system 20,000 K. V. A. 11,000 volt transformers, 125,000 K. V. A. 50,000 volt transformers, and 155,000 K. V. A. 100,000 volt transformers. Self-cooling transformers as high as 2,000 K. V. A. are now in service and have given excellent satisfaction up to the present time. The first 1,000 K. V. A. self-cooling transformers have been in service for two years. On the 100,000 volt main lines endeavor has been made for operating and other reasons to tap-off for sub-stations at as few points as possible. With this end in view transformer stations stepping down to 13,000 volts have been installed where several mills and towns can be reached from one station. Outdoor sub-stations, stepping down from 13,000 volts to 2,300 or 575, are installed at the mills. This type of sub-station has been very satisfactory,

as it is reliable, cheap, quickly installed and easily changed or enlarged. As an example, reference is made to Durham, N. C., where there are installed in main transformer station three 2,000 K. W. transformers and at the mills the following outdoor transformer stations: One 3,000 K. W., one 1,500 K. W., one 900 K. W., and one 450 K. W. In this main station provision has been made for three additional transformers to supply power to the remaining mills and for circuit breakers for proposed extension to 100,000 volt line.

REGULATION.

On a system covering so large a territory and with so many points of delivery there will be a wide range of delivered voltage at full load. This is taken care of by taps on transformers covering wide variation of voltage. All sizes of transformers have standard taps. Variation of voltage, at centre of distribution, due to changing load (such as occurs at 6.00 a. m., noon and 6.00 p. m., when load comes and goes off very rapidly) is provided for by varying excitation current. Generators are built to operate fifteen per cent above their rated voltage continuously. At points some distance from these centres of distribution voltage regulators are used by consumers on lighting loads, but comparatively few are used in cotton mills where it must be regulated by the consumer. Since the 100,000 volt lines have been put in service the regulation has been very much improved, due to improvement in power factor.

OPERATION OF THE SYSTEM.

Ordinarily the whole system is operated in parallel, but it is so arranged that by throwing a few oil switches each power house can supply power to an independent group of lines. These oil switches are not only used to sectionalize during lightning storms, but in case of trouble they are opened in order to give operators a better opportunity to test out. They are also opened at night, except in periods of low water.

Sometimes one division in which the storm begins is separated from the remainder of the system, and if the storm reaches the remaining lines, sections are cut off as it approaches. Each operator has instructions to call up the dispatching office as soon as he sees a storm coming up. This section of the country is subject to severe lightning storms from early in the spring until late in autumn, and the records show that it has sometimes taken twelve hours for a storm to work clear of the lines. It may start at one end of the system, work entirely across and part of the way back. Each generating station and each important sub-station is in charge of a superintendent and a corps of experienced operators. At other points division superintendents have charge of a group of sub-stations, at each of which there may be one or two attendants. All lines are patrolled at least once a week—an average of about 35 miles to the man. Trouble is reported direct to despatcher, who immediately reports it to the man in charge of all line work. For repair work this man has two experienced assistants—one in charge of 100,000 volt lines, and the other in charge of 50,000 volt lines. At various points on the system where the patrolmen are stationed, block and tackle and repair parts are stored. All these patrolmen are in telephone communication with despatcher's office, and when repairs are necessary a number of them are assembled by the man in charge.

Operators in generating and switching stations have instructions what to do in case of trouble when telephone communications are cut off, the general instruction being to "push current in front of you." On 100,000 volt lines the sub-station operators can cut into either line which shows voltage first, by having two circuit breakers interlocked so that they cannot both be closed at once. Readings of load and height of water in each station, and of height of water in each pond in reference to crest of dam, are taken hourly and telephoned to dispatcher's office. These readings are plotted and load is passed from station to station, so as to make the most economical use of the water. For instance, the heaviest load carried on the Catawba station is from 11 a. m. to 11.00 p. m. The water which passes from the Catawba wheels reaches Great Falls (33 miles distant, air line) at 7.00 o'clock next morning (20 hours). The load is then taken off Catawba station and the pond allowed to fill up. Secondary power is thrown on or off the system as water permits, and the dispatcher is in telephone communication with head waters of river, in order that secondary power can be kept on as many days as possible.

Fig. 13. Spartanburg Tie-in Station.

Every station has flash boards from 1½ to 2 feet in height. These flash boards are supported by 4-inch x 4-inch uprights, and will wash off with high water. Records of all trobules, giving place, time, and cause, are so kept that a comparison from month to month, and from year to year can be readily made.

FEATURES OF LINE CONSTRUCTION.

The advantages and disadvantages of one form of construction as against another, depends too much upon local conditions to be discussed in detail in this paper, but a few observations may not be amiss. First, the scattered condition of the market necessitates many miles of line and many sub-stations. Secondly, as the average price of coal is about $3.50 per ton, and as the great majority of the mills had their own steam plants, the price of power is so low that costs of construction must be carefully considered. Poles were first extensively used for 50,000 volt lines, due to the above consideration, and for the additional reason that lines had to be built without positive knowledge that any great amount of load would be contracted for. The pole lines have given excellent service, but their life has been very short. Cypress poles have been entirely replaced in five years, and it is now apparent that chestnut and juniper poles will have to be replaced in seven or eight years. A 50,000 volt wood pole line, with 2/0 B. & S.

copper, can be constructed in this district for approximately $2,000 per mile. A tower line with the same insulators, can be built for less than 50 per cent additional and a double circuit tower line can be built at approximately the same cost as two single pole lines. It seems, therefore, that it would be much more economical to build steel tower lines rather than pole lines, when the line is to remain unchanged for fifteen or twenty years. The steel tower line requires greater insulation, but when a large amount of power is to be carried the double circuit steel tower has many advantages over the wood pole line. However, it would appear from experience gained on these lines that if the poles were cut at the proper season, allowed to dry thoroughly, and brush treated while dry, and also every three years after being put up in the ground, the life would be very much longer.

When greater line insulation is advocated, it is generally met with the argument that if the line insulation were greater than that of generators, transformers, or other station apparatus, then the break down from abnormal voltages would occur at stations. This is where it should occur, if it is going to take place at all, where the trouble can be quickly inspected, and not out on the line where hours, and possibly days, are required to locate trouble. Moreover, it is much easier to make provision for taking abnormal voltages off the line at a few stations than on hundreds of miles of line.

The writer does not assume that a line can be insulated so that no trouble will occur in lightning storms, but experience shows that there is very much less trouble on the 100,000 volt lines than on the 50,000 volt lines. In fact, the 100,000 volt lines of the company have never been put out of service by lightning, except for the time that it takes to close a circuit breaker. The extra cost of insulation not only insures against momentary interruption, but lessens the number of spare lines or other provisions made to insure continuity of service. In one instance the large petticoats on three out of four insulators were shattered in a severe lightning storm, and no interruption of service took place, except the opening of a circuit breaker. The line operated in this condition for five days.

FIG. 14. 100,000 VOLTS SUSPENSION INSULATORS WITH CLAMP AND SHIELD ON ALUMINUM WIRE.

In published descriptions of engineering work very little is ever said regarding the cost, and it has always seemed unfortunate that more information on this subject could not be given the reader. In different parts of the country, of course, the local conditions vary so much that the cost in one case would not be a criterion for another, but if the local conditions are known in both cases the estimate can be modified to suit the new conditions. A knowledge of itemized average costs enables an engineer to apply the knife at the point where large savings can be made, instead of devoting his energy to items where little saving can be accomplished. Furthermore, unless one has taken the trouble to look this matter up, it is rather interesting to note the cost of the steel, conductor, insulators, etc., in percentage of total cost.

The following is given as the cost of a 100,000 volt tower line, using 00 copper conductor where conditions are similar to those in the Carolinas. The spacing is 9 towers to a mile—8 suspensions and one strain. Right of way not included:

Towers	27%
Insulators	8%
Clamps	1%
Ground wire	2%
Conductor (6 No. 00 copper)	42%
Labor	15%
Interest during construction	3%
Engineering, supervision, and surveying, general office expenses	2%
	100%

It is to be noted that by far the largest item is conductor, and that insulation is a comparatively small factor. It might be well to emphasize here that a small additional percentage cost of tower in comparison with total cost of line may add greatly to the factor of safety of line.

The item of labor may further be seggregated as follows:

Digging holes	23%
Hauling and distributing towers	9%
Assembling	8%
Erecting	14%
Filling in holes	7%
Hauling and distributing insulators	8%
Hauling and distributing wire	6%
Stringing 6 conductors and 1 ground wire	25%
	100%

Candle power is the measure of the luminous intensity of a source of light.

The new candle power unit is 1.6 per cent. smaller than the old one and is called the International Candle. It is at present the standard candle-power unit in the United States, France and Great Britain. The German or Hefner is .9 of the International Candle.

Mean horizontal candle-power is the average candle-power given by a source of light in a horizontal plane when the source is supported vertically.

Instrument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)
BY E. P. PECK, ASST. ELECTRICAL ENGINEER
FOR GEORGIA RAILWAY AND ELECTRIC COMPANY.

Care and Use of Portable Instruments—Subject Continued from February Number.

THE testing department of a central station is constantly called on for tests of its own and its customers' apparatus. These tests are of widely varying character, requiring various degrees of accuracy, and on apparatus from the smallest to the largest. Such tests may be made only with portable instruments, an equipment of these instruments is therefore essential, if the central station cares to have satisfactory information on its equipment and circuits. Further in many cases of trouble originating in the generating or transforming apparatus, portable instruments are necessary for locating the trouble, for checking after repairs, and for determining the causes of the trouble. Among the many tests required by the central station are the following: tests of watthour meters; acceptance and efficiency tests on new generators, transformers, rotary converters, etc.; motor tests, which commonly are made to determine the load on various motors for the customer; transformer, line and apparatus tests, for investigation purposes or to locate trouble.

Most large central stations have both alternating and direct current, so the instruments must cover both systems. For direct current work the voltmeter, with ranges suited to the voltages of the system, and milli-voltmeters with shunts are recommended. The milli-voltmeter and shunt is suggested in place of the self contained ammeter for the following reasons: It is generally found to be more correct with varying temperatures; will carry load continuously without heating errors; it is easier to keep the instrument away from the current carrying leads, and last, but probably the most important reason—several shunts of different capacities may be used with the same instrument. One laboratory has a milli-voltmeter with one, five, ten, fifty and 250 ampere shunts, and another with 25, 100, 250, 500 and 1,000 ampere shunts. With only two portable instruments an extremely wide range of tests may be made.

Direct current watthour meters may be calibrated and the whole range of miscellaneous tests may be made with the instruments mentioned above, except that different capacity shunts may be necessary, and more meters may be kept in use. If a large number of watthour meters of the same capacity are tested regularly, a milli-voltmeter with only one shunt of suitable size would be used, as the extra shunts would represent an idle investment in this case.

For alternating current tests, alternating current voltmeters, ammeters and wattmeters are needed. Voltmeters should have ranges suited to the system's secondary voltage, the primary voltages being measured through potential transformers. A large number of wattmeters and ammeters of different capacities are often purchased to care for the low voltage A. C. tests, but for general testing, a large assortment of meters is not recommended. Two wattmeters, with 150 and 300 voltage coils and 5 ampere current coils, three 5 ampere ammeters, two portable current transformers of the "doughnut" type, and three 150 and 300 volt voltmeters, will cover almost any A. C. test on motors, transformers, generators, etc. For high voltage work in stations the station potential transformers may often be used. If these are not available, two portable transformers, of the proper ratio may be used. The advantages of the above layout are: Eight meters will cover a wide range of testing; the meters are of similar capacities and are thus easily checked, and there is no investment in idle meters.

The connections and methods of using meters and transformers will be taken up under the headings of the separate tests in later issues.

If a large number of watthour meters are to be tested regularly, it may be advisable to have other indicating wattmeters of capacities suited to the watthour meters, but the rotating standard meter is rapidly replacing the indicating meter for this purpose, as it is adapted to more rapid and satisfactory use. The rotating standard may be checked on the five or ten ampere coil and thus eliminate the need of the other indicating meters. Tests on lamps and other very small loads may require the use of meters of lower capacities, but tests on alternating current below the accurate range of a five ampere meter are rare in central station work and probably would not justify the purchase of special meters.

A very useful accessory to the wattmeter is a star box adjusted to the meter. By means of the star box a three

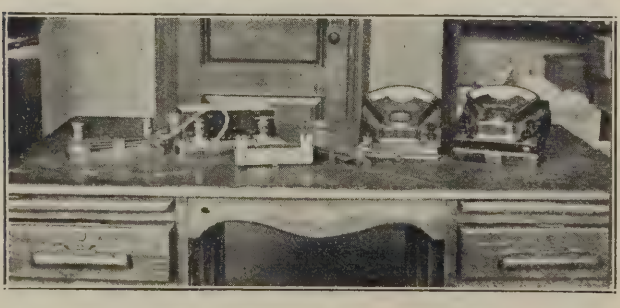


FIG. 1. DIRECT CURRENT VOLTMETER, MILLIVOLTMETER AND SHUNTS.

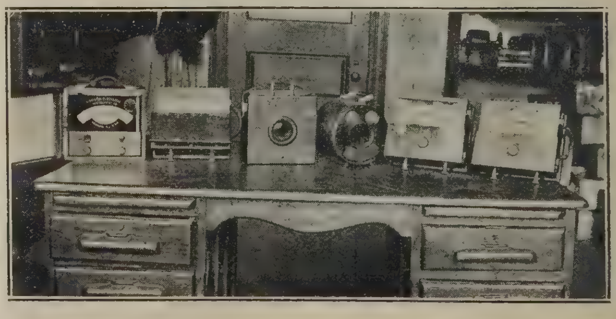


FIG. 2. A. C. TRANSFORMERS, WATTMETERS, AMMETER, AND VOLTMETER.

phase motor test may be made using only one wattmeter. The accuracy of such test is not as great as when using two wattmeters, but the test is so much simplified that its use is recommended for general load tests on motors.

PREPARATION FOR TESTS AND SELECTION OF METERS.

When preparing for any test involving the use of several meters and a large number of connections, it is best to draw a diagram of all connections and work out the proper capacity of each meter. By this means mistakes in connections are made less probable and tests rendered more accurate, because meter readings will come in the accurate parts of the scales of the instruments. A meter too small for the load is thus saved from damage and the one too large for acurate results is avoided.

All connecting wires should be of ample size to prevent heating, as heat from the leads is conducted into the meters and inaccuracy may result. In all kinds of testing, particularly when heavy currents are used, the instruments should be kept away from the leads and care should be taken that a loop of a conductor carrying current is not formed around a meter. All splices should be taped even in the most temporary of connections. If this is not done, the meters are often damaged. Connecting wires must never be allowed to hang down from the testing bench for they are liable to be caught accidentally and the meters pulled from the bench.

Portable indicating instruments are made on a number of different principles and the construction of different types of meters varies widely. Instruments for use on direct currents are usually of the permanent fixed magnet and moving coil type, but hot wire meters, iron vane meters, and meters on the Kelvin balance principle are also made. For use on alternating current circuits some form of the electro-dynamometer is the most common form. There are also induction meters, iron vane meters, hot wire and Kelvin balance types. Most of the details of construction and use, which are taken up here will apply to the most widely used forms, the D'Arsonval and the electro-dynamometer. In each of these types of meters there is a moving coil, supported above and below by conical steel pivots in jewel bearings. The movement of the system is caused by the reaction of the magnetic forces in the moving coil and the field. The restraining force is supplied by two springs which serve the further purpose of carrying current to the moving coils.

The moving systems are made in such a way as to provide sufficient driving force, have proper mechanical strength and be as light as possible. With the lightest possible moving system, the weight per square inch on the microscopic

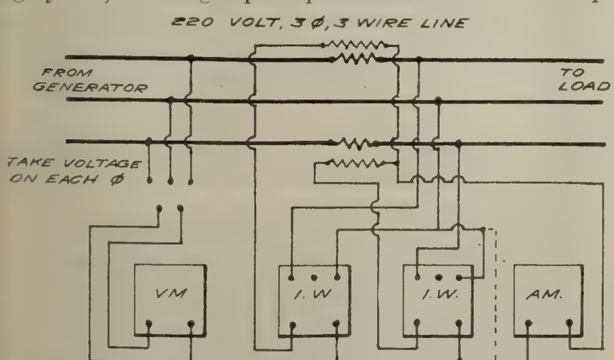


FIG. 3. METER CONNECTIONS FOR TEST ON 220 VOLT, 3-PHASE, 3-WIRE CIRCUIT, USING TWO WATTMETERS AND TWO CURRENT TRANSFORMERS.

point of the pivot is enormous. As a result, even the best jewels and pivots are often roughened or broken by a slight jar of the meter. The relative positions of the pointer and coil are fixed, and should the pointer become bent, it must be put in the same relative position to the moving coil as it was originally. If the pointer be bent off zero and set back by moving or bending the springs, inaccuracy of calibration will result. The hairsprings are likewise fixed to the coil and are balanced against each other. If the springs are overheated, or permanently distorted, it is difficult to obtain accuracy in all parts of the scale. In other words, the relations of the moving coil, pointer and hairsprings are fixed, and in a proper relation to the fixed magnetic field. If any of these relations are disturbed, the proportionality of the deflection is changed, and the scale is no longer correct for the changed conditions. In case of any derangement of these parts, they should be put in their original condition, or a new scale put on the meter, if accuracy over the whole scale is required. A meter scale is very difficult to properly make and for this reason the old scale is generally retained and a curve showing the error of the meter used. A meter in constant use is liable to change in calibration, hence it is well to check meters regularly at weekly intervals and make new curves when necessary.

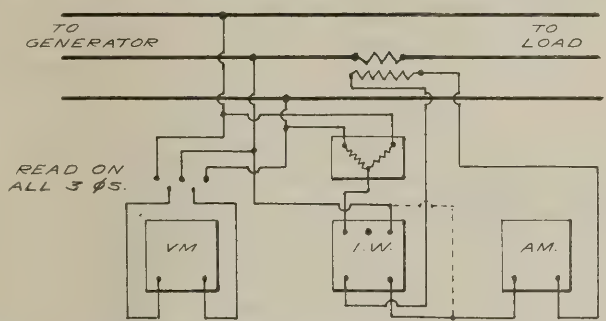


FIG. 4. METER CONNECTIONS FOR TEST ON 220 VOLT, 3-PHASE, 3 WIRE CIRCUIT USING ONE WATTMETER AND ONE TRANSFORMER.

All portable instruments are liable to give incorrect results if any disturbing influences are present. Stray fields may cause errors of several per cent in either alternating or direct current meters. If meters are placed with their cases together, each will influence the readings of the other. Meters should be separated about 18 inches when accurate results are required, and should not be used near any mass of iron.

Practically all meters are subject to temperature errors, direct current ammeters, particularly in the large sizes, being most subject to these errors. A change in temperature which affects the whole meter generally has a negligible effect, but the heating due to load is not uniform. The shunt heats more than the moving element, and one terminal of the shunt often heats more than the other terminal. This local heating may in some cases give errors amounting to several per cent. A properly proportioned meter and separate shunt is the best combination to use for direct current work. If the leads are of sufficient size and connections well made, heating errors may generally be neglected for all but the most exact work. It is well, however, to feel the connections to the shunt during the test to see that there is no unequal heating.

A shunt should give 50 milli-volts drop at least and better results are obtained with a drop of 100 milli-volts. For exact work, shunts are often made giving 200 milli-

volts drop. The 200 milli-volt shunt must be about four times as large as the 50 milli-volt shunt, and on account of not being so portable is not recommended for general testing. There are two reasons for the combination giving the highest drop having the highest working accuracy. One is that a given milli-volt error due to thermo voltages is a less per cent if the drop across the shunt is higher. The other is that the resistance wire, in series with the movement in the meter, has a higher resistance in the meter for a higher drop or working voltage. As this resistance wire is of low temperature coefficient metal, the more of it there is in series with the movement, the less a given temperature change will change the total resistance of the meter and hence the less the meter error for temperature changes. Some makes of alternating current voltmeters and wattmeters are particularly subject to heating. When such a meter is used, the potential circuit must be kept open except when actually taking readings.

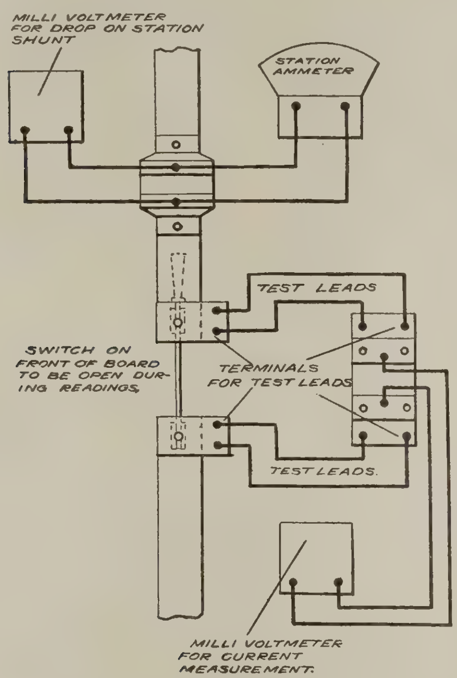


FIG. 5. CONNECTIONS FOR TESTING STATION AMMETERS.

Rubing the glass or the hard rubber top of a meter to remove dust will sometimes give a static charge on the part rubbed which will cause the pointer to deflect. The charge should be removed before taking readings, which may be done by breathing on the glass and touching it with the finger.

In many indicating wattmeters there is an electrostatic force exerted between the moving element and the stationary parts, when the instruments are connected to voltage and current transformers. This troublesome error may be eliminated by connecting together one voltage and one current post of the meter, but this connection must be made only after proper investigation to see that trouble will not be caused by an interconnection of the transformer secondaries at some other point.

A point already mentioned which is often overlooked when using meters, is to have the capacity of the meters with reference to the value to be measured such that the reading comes as high as possible on the scale. If a meter has a maximum error of one-fifth of one small division, the

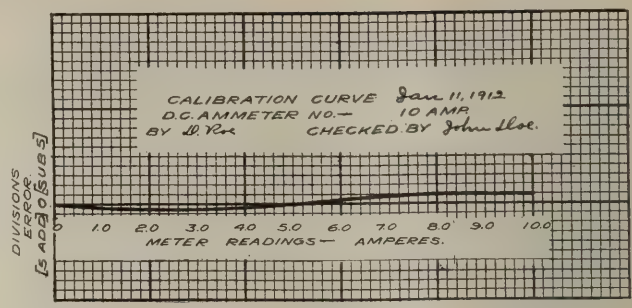


FIG. 6. CALIBRATION CURVE OF D. C. AMMETER.

per cent of the actual reading in a 150 division scale will be as follows:

Divisions	150	100	50	10	5
Per cent error...........	.2	.25	.4	1.5	3.1

This error is shown for the complete scale of the meter in the curve of reading errors in Figs. 7 and 8. The curve shows that for a given accuracy of calibration, the greatest accuracy of measurement is obtained when the pointer is indicating the highest reading, and for low readings, say below one-third of the scale, the accuracy falls off very rapidly. One of the great advantages of the "doughnut" type of transformer for alternating current work, and the shunts and milli-voltmeter for direct current work, is that the capacity of the test meters is easily varied to suit the requirements of the test.

The connections for most tests are easily made, but when large ammeters and watthour meters from 500 to 5,000 amperes capacity, are to be checked, the connection is often a serious problem. This is particularly the case when the only possible method of loading the meters is to use the regularly connected load, and when the temporary connections and test meters must carry this load until the line that the meters are on can be opened again. In many cases the test meters must be installed late at night, the test made during the day and the meters taken out the next night. In this case, all temporary connections must be of ample capacity and the meters of sufficient size to stand the maximum load without damage. In central station work many tests of this nature are necessary.

The writer has arranged a very flexible and satisfactory method of temporary connections for meters from 500 amperes to 1,500 amperes capacity. Ten 0000 leads, about five feet long, were made up of the very flexible leads used for connecting from machine terminals to generator arma-

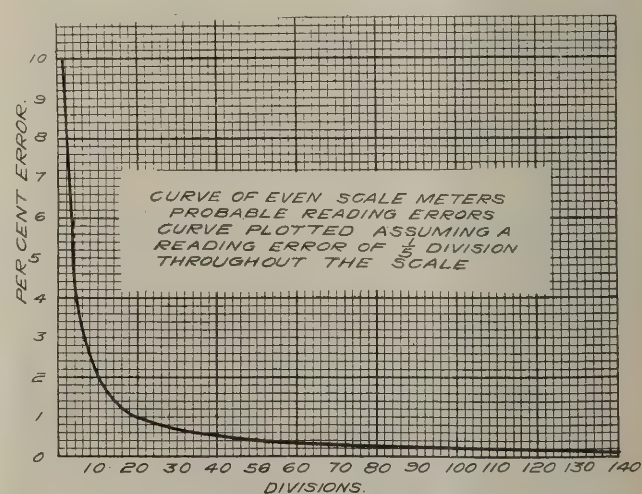


FIG. 7. CURVE OF PROBABLE READING ERRORS FOR EVEN SCALE METERS.

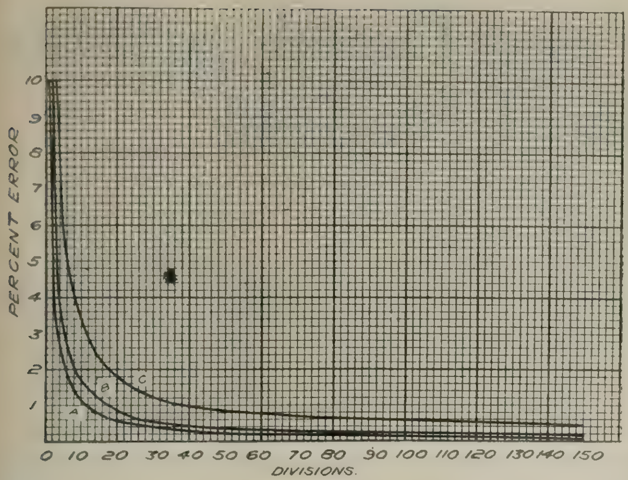


FIG. 8. CURVES OF PROBABLE READING ERRORS FOR METERS.

tures. Special open end lugs to fit these leads, terminal plates to fit the different shunts, and other terminal plates to fit the switchboard studs, were made. Terminals for the 500 ampere shunts and switches were bored to take two flexible leads and for the 1,500 ampere shunts, the terminals take five leads each. Thus the same leads will do for a variety of work. To make the test, the terminals for the switchboard are bolted on the studs of a switch in series with the meter to be tested, and the leads are connected from these terminals to the shunt. When ready to take readings, the switch is opened and the test meter thus put in series with the station meter. After the test is completed, the switch is closed and the leads removed.

Tests of the above character are troublesome and expensive, and to avoid repeating the whole work every time the station meter is tested, data is taken on the first test so that the resistance of the shunt may be calculated. A milli-voltmeter is connected to the meter lead connections on the shunt and simultaneous readings taken on the standard ammeter and milli-voltmeter. A large number of readings are taken with the standard meters turned 180 degrees after each reading to eliminate stray field errors. From these readings the resistance of the shunt and the milli-volts drop per 100 or 1,000 amperes is figured. After this constant is once determined, it is not necessary to put the standard ammeter in the line for other tests. It is only necessary to connect a milli-voltmeter across the shunt and compare the amperes read on the station meter with the amperes computed from the milli-voltmeter reading. Unless a shunt has been overheated or otherwise damaged, it is very constant in resistance and the constants need only be determined once. All of the original readings and computations should be entered in the meter record envelope for future reference.

If a large ammeter is dameged it may be taken to the laboratory, be repaired and calibrated, with its leads, against the milli-voltmeter or potentiometer, using any small shunt to give the voltage for the meters. The standard meter should be connected to the shunt end, not the meter end, of the leads to the station meter.

Tests on ammeters larger than 1,500 amperes require greater current carrying capacity than the set of leads provide, and each connection is often a separate problem. It is advisable to get the constant of the shunt from the manufacturers if possible and thus save the labor of measuring it.

It is not possible to cover in any article all of the uses of even the most common meters, in fact, many pages could be written and not give complete information on any one meter. The tester must work out his individual problems as they come up, and not be discouraged if the proper solution does not come easily. Most electrical engineers in the country find that the proper method of measurement, in their investigations, is the hardest and in many cases the most important problem of the investigation.

The following is an explanation of meter reading error curves: The Westinghouse Elec. & Mfg. Co. publishes the formula: Per cent error $=(aC-bc)/c$, for calculating the error of calibration of a meter, and, the following explanation of the formula is given in their circular. "In all indicating meters there are errors of two kinds; initial errors independent of the load, due to traces of friction, parallax, coarseness of the divisions of the dial, etc., and errors proportional to the reading due to inaccuracies in calibration, errors in standards used and causes varying the constants of the instrument. The accuracy of the calibration may therefore be expressed by saying that the errors of the first kind amount to "a" per cent of the full scale reading, and those of the second kind to "b" per cent of the actual reading. Then the error of calibration at any point is given by the formula: Per cent error $=(aC-bc)/c$.

"In which C = full scale capacity as connected and c actual reading.

"For type P meters $a=.2$, $b=.3$.

"For type Q meters $a=.1$, $b=2$."

The curves shown in Fig. 8, "a," "b," and "c" are plotted from the formula. Curve "a" is a curve of possible reading errors on the Westinghouse Precision Wattmeter; curve "b" is a curve of Weston D. C. Voltmeters, plotted according to the same formula, in which x and y are made equal to .1, as I believe these constants are as small as they can be taken consistently; curve "c" is a curve of Westinghouse Type P, Portable Indicating Wattmeter. The curve in Fig. 7 is plotted on the assumption of a total error of .2 of unit division through the entire scale on an even scale meter. This assumption agrees with the usual guarantees on the meters, and is justified when the meter is used under average conditions. Curve "7" is interesting in that it is an hyperbola. In this curve, of course, the product of the divisions and the per cent error is a constant.

In Fig. 3, it should be noted that true watts from the connections equals the algebraic sum of wattmeter readings multiplied by the current transformer ratio. True amperes equals ammeter reading multiplied by current transformer ratio.

True watts from connections in Fig. 4 equals three times meter reading, times current transformer ratio. True amperes equals ammeter reading times current transformer ratio.

The lighting of churches is dependent on their architectural style, and the outlets should be so placed as to bring out the peculiarities of the style. Colonial churches may have a center ceiling outlet with additional ceiling outlets over the balconies, and wall brackets under these. In Romanesque and Gothic churches in which the roof trusses are supported by center beams an opportunity is afforded for the location of pendent outlets on the extremities of these beams, with one outlet on the ridgepole over the gallery, where the church includes a gallery.

Conditions, Practice and Developments In English Central Stations.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY CECIL TOONE, AN ENGLISH ELECTRICAL ENGINEER.

Section 3.—Reciprocating Engine and Turbine Installations in English Central Stations.

THROUGH this article and the succeeding one, dealing with oil and gas engines and water turbines, the writer hopes to set forth the prevailing practice in prime mover installations in England. The present section is confined to a consideration of steam engines and turbines. Of some 1,076,000 kw. of central station plant now in service in the United Kingdom, the approximate amounts operated by various prime movers are shown in Table I. No further demonstration is needed of the overwhelming majority of steam driven stations in this country. Nowhere have we waterfalls in the least comparable with those supplying the large American hydro electric schemes and although gas engines of 1,000 and 2,000 horsepower are fairly common in certain private generating stations at collieries, no public supply station of over 600 kw. total capacity is wholly gas driven in this country and, so far as the writer is aware, the largest water power station is of 500 kw. and the largest oil driven station of 250 kw. total capacity.

TABLE 1—TOTAL KILOWATT CAPACITY OF UNDERTAKINGS OPERATED BY VARIOUS PRIME MOVERS.

	Recip. Steam	Steam Turbines	Gas	Oil	Water
Station Group L	217700	47900	7600	950	1400
Station Group M	230000	14100	----	----	----
Total—Groups L, M	447700	62000	7600	950	1400

	Recip. & Turbines	Recip. & Gas	Recip. & Oil	Recip. & Water	G. & O. G. & W. and O. & W
Station Group L	265000	3450	3420	1790	1530
Station Group M	276500	3800	1120	----	----
Total—Groups L, M	541500	7250	4540	1790	1530

NUMBER OF GENERATING UNITS AND TYPES OF ENGINES.

There is neither space nor necessity to enter into a detailed description of the various types of prime movers now in use in English central stations. Doubtless the majority are as familiar to American as to English readers and all are described in standard text books should precise technical details be required. Regarding the relative costs and merits of various prime movers, the reader may refer to Steinmetz, Am. I. E. E., Feb., 1909. Before considering which types are most popular in England, attention may well be drawn to the usual number of generating sets in stations of various kilowatt capacity and to the usual relative capacity of these units. Such matters will have to be considered in greater detail in Section 5 of this series of articles, dealing with spare capacity, load factor, etc., but the present is an opportune moment at which to introduce Tables 2 and 3. The kilowatt ranges of station capacity adopted in the following classifications are those enumerated in previous articles, but for the kilowatt capacity of individual generating units, a somewhat finer subdivision is desirable. Analysis on the basis of "present" kilowatts naturally includes conditions and plant which obtained or was installed respectively when the station was under a different kilowatt group. This is inevitable, but, as these notes deal with present conditions, rather than with installation considerations, the effect of this change in group is mainly apparent.

Table 2, showing the average number of generating units in 231 stations of group L (no traction load), and 148 stations of group M (with traction load), needs no special comment. Up to 10,000 kw. station capacity the number of generating units and the average kilowatt capacity per unit advance as consistently as can be expected in such statistics, but in the larger stations, less concordant results obtain, owing to the fewer number of such stations on which averages can be based and owing to the use of large turbine units of from 2,000 to 5,000 or more kw. capacity in some of the stations whereas, in other cases, reciprocating units of smaller average capacity are still employed. Table 3 is based on an analysis of the plant contained in some 140 stations, roughly half of which belong to group L, and the remainder to group M. This table though less complete than Table 1, serves to still further illustrate the general proportioning of the units in various stations. Precise data of all English stations is not yet hand but is being accumulated as fast as possible for the express purpose of use in these articles. Where only a

TABLE 2—NUMBER AND SIZE OF GENERATING UNITS IN STEAM DRIVEN STATIONS.

	Station Capacity—Kilowatts. 0 to 100	100 to 250	250 to 500	500 to 1000	1000 to 2500	2500 to 5000	5000 to 7500	7500 to 10000	10000 to 15000	15000 to 20000	20000 to 30000	30000 to 40000
Group L: No. of Stations	11	31	40	58	42	22	8	7	5	5	1	--
Group L: No. of Units	2	3	3	5	7	9	11	12	16	12	15	--
Group L: Average Kw.-Unit*	25	58	125	150	500	417	568	730	780	1460	1670	--
Group M: No. of Stations	--	--	6	25	65	28	13	3	3	3	1	1
Group M: No. of Units	--	--	3	4	7	9	10	13	23	9	13	54
Group M: Average Kw.-Unit*	--	--	125	187	500	417	625	670	540	1945	1920	650

*Assumed to equal Mean Station Capacity Divided by Mean Number of Units.
The 67000 kw. Newcastle undertaking, (Group M), has 16 main generating sets; i. e. an average of 4200 kw. per unit.

limited number of stations is concerned, this number is stated and the extent to which the results are generally applicable is indicated. In all such cases, every endeavor has been made to include sufficient stations (and of such a class), to make the results thoroughly typical. As already noted, the use of turbo-generators in large stations results in a few units, all of large capacity, in such cases. In general, we find in large undertakings, a number of large generating units and a considerable number of small auxiliary sets, the latter in no sense acting as standby plant or directly aiding the output of the main sets. A more complete analysis of the size of generating units and its influence on the general operating characteristics of central station will be attempted in Section 5 of this series but it may at once be noted that the ratio of division of a given load between various machines exerts much less influence on the total steam consumption than is generally believed.

opment in the size of generating units during the closing years of the nineteenth century. Thus, in a description of the Portsmouth station in 1894 we find a comment on the economy likely to be effected by the use of "such relatively large units as 150 and 200 kw. sets, yet in 1897, two 3,500 kw. Corliss engines were installed at Manchester (these being then the largest D. C. sets in Europe), and in 1902 it was generally recognized that turbo units of from 3,000 to 6,000 kw. capacity would be demanded in the near future.

No attempt can here be made to analyze the utilisation of the many types of engines which go to make up sor 27½ per cent of the total number dealt with nor would any useful purpose be served by classifying the various combinations of units used in different stations. Many stations have a thoroughly homogenous equipment (particularly on the steam side), each extension unit being

TABLE 3—NUMBERS OF GENERATING UNITS OF VARIOUS CAPACITIES IN SOME 140 STATIONS (OF GROUPS L & M).

Station Capacity (1000' Kw.)	No. of Stations	No. of Units of Capacity (Kw.) between— 0 and 50	50 and 100	100 and 200	200 and 300	300 and 500	500 and 750	750 and 1000	1000 anf 1500	1500 and 2000	2000 and 3000	3000 and 4000	4000 and 5000	Over 5000
0.0– .1	7	8	2	--	--	--	--	--	--	--	--	--	--	--
.1– .25	23	12	30	14	--	--	--	--	--	--	--	--	--	--
.25– .5	40	11	46	68	5	--	--	--	--	--	--	--	--	--
.5– 1.0	22	3	14	30	27	8	1	--	--	--	--	--	--	--
1.0– 2.5	16	3	6	27	11	20	11	7	--	4	--	--	--	--
2.5– 5.0	15	--	8	6	5	18	19	2	11	11	2	--	--	--
5 – 7.5	6	--	--	9	7	10	12	6	4	6	--	--	--	--
7.5–10	1	--	--	--	--	--	--	3	--	4	--	--	--	--
10 –15	3	--	--	--	--	--	7	--	11	8	2	--	--	--
15 –20	1	--	--	--	--	--	--	8	--	--	--	3	--	--
20 –30	2	--	--	--	--	--	--	10	1	6	--	2	2	1
30 –40	1	--	--	--	--	--	--	--	--	--	--	4	4	--
Totals	137	37	106	154	55	56	50	36	27	39	4	9	6	1

Turning now to a consideration of the makes of engines employed in English central stations, the Belliss and Willans engines are far predominant and are themselves used to a nearly equal extent. These types are deservedly popular in large and small stations alike, though both are, of course, inferior to steam turbines where very large units are required. Without wishing to venture too far on the basis of limited statistics, it certainly appears from Table III that Belliss engines predominate in stations of less than 2,500 kw. capacity and the Willans type in larger undertakings. Thus, among 250 stations of less than 2,500 kw. capacity, there are employed 411 Belliss engines and 262 Willans engines while among 92 stations of over 2,500 kw. capacity, there are 179 Belliss and 302 Willans engines. The Belliss and Willans figures coming under the station range 2,500-5,000 kw. are very peculiar but it is unsafe to draw any particular conclusion therefrom. As the result of using a few large cylinders in Belliss engines as against a larger number of small cylinders in the Willans type, a higher efficiency of 10 per cent is usually estimated in the former case.

The Browett-Lindley engine is much used in stations up to 2,500 kw. capacity but is seldom encountered in larger undertakings; the same remarks apply to the Allen and Peache engines. The Sulzer and Corliss engines on the other hand are essentially high horsepower types, are rarely built in smaller units than 1,500 horsepower and are thus generally found in stations of 2,500-7,500 kw. capacity. Turbines may be expected to ultimately replace all large reciprocating engines and where very large units are required, new generating sets are invariably turbo-driven.

To the student of central station development, there can be few more interesting features than the rapid devel-

ordered from the makers of the original plant. In many other cases, however, several types of high speed engines are used in one station and, more rarely, mixed high speed and low speed units are employed. In at least one large station, the urgency of installation was responsible for the adoption of a very mixed plant. The greatest interest attaches to heterogenous installations where some turbine and some reciprocating units operate in parallel. Paralleling difficulties often arise under such circumstances owing to the absence of phase swing in turbo-units and the great inertia of the rotor which prevents it from oscillating in sympathy with the fluctuations of the reciprocating sets. Such difficulties are naturally greatest where turbo-sets operate in parallel with slow speed reciprocating engines and, unfortunately, it is in large installations where the latter are used that the problem has usually to be faced.

The results of an analysis of the turbine plant in 95 central stations in the United Kingdom (including practically all stations employing these prime movers), are presented in Table 4 which shows the Parsons turbine to be by far the most generally employed in this country. This type is manufactured under license by various firms and, though the essential features are the same throughout, many important constructional differences are introduced by the various makers. The vertical shaft Curtis turbine is considerably employed and possesses merits and disadvantages, as compared with the Parsons type, which are too well known to need recapitulation. The Laval turbine is lttle used owing to the relatively small units in which it must necessarily be built (say less than 400 kw.), and owing to the very high speed at which the main shaft revolves. The Zoelly, Rateau, Stumpf and other Continental turbines are used to a very limited extent in England.

TABLE 4—NUMBERS OF VARIOUS TYPES USED IN 95 ENGLISH CENTRAL STATIONS.

Type of Turbine.	Total Capacity of Undertaking (1000 Kilowatts.)																		
	.25–.5	.5–1.0		1–2.5		2.5–5.0		5.0–7.5		7.5–10		10–15		15–20		20–30		30–40	Totals
	Group L	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	Group M	
Parsons (1)	10	13	--	15	31	19	3	8	6	22	5	18	2	6	4	2	3	--	167
Curtis	--	--	2	2	--	2	1	2	--	6	--	--	--	--	--	--	--	6	21
Miscellaneous (2)	--	--	--	--	1	7	5	2	9	2	3	--	--	--	1	--	3	3	36
Exhaust and Mixed Pressure	--	1	--	6	3	1	--	--	--	--	--	4	--	--	--	2	--	--	17
No. of Stations D. C.	3	6	--	6	9	3	1	1	--	1	1	2	--	--	1	--	--	1	35
No. of Stations A. C.	--	--	1	5	8	10	5	4	8	7	2	2	1	2	1	2	2	--	60
No. of Stations D. C. and A. C.	3	6	1	11	17	13	6	5	8	8	3	4	1	2	2	2	2	1	95
Total Stations L. & M.	3	7		28		19		13		11		5		4		4		1	95

1By various makers—mainly Parsons and Willans.
2Including Oerlikon, Zoelly etc.

Comparisons are ever liable to be invidious but, on seeking to contrast the efficiencies of the Parsons and Curtis turbines as typical of reaction and impulse types respectively we are forced to the conclusion that about half the authoritative tests available claim five per cent superiority for the Parsons type and the other half claim five per cent advantage for the Curtis machine. There is little to choose between the types from the efficiency point of view. The Parsons turbine appears to take better advantage of superheat than the Curtis type but the latter possesses the valuable characteristic that its steam consumption rises but slowly with decreasing load so that a 1,500 kw. unit taking 17½ pounds steam per kw. hour on full load may be run at one-third full load for a specific consumption of 20 pounds per kw. hour. Owing to the difficulty of building very high speed D. C. generators, about 65 per cent of the turbine driven units in this country supply alternating current as shown in Table 4.

Exhaust and mixed pressure turbines are already in considerable favor in English stations and there can be no doubt that they will be widely adopted as extensions become necessary in existing reciprocating plant. Whether their utility is confined to such cases or whether it is economical to lay down combined reciprocating and exhaust turbine plant in the first instance is still a moot point. It is obviously advisable to employ as much exhaust steam as possible for feed heating since the latent heat of the steam is then utilized but is of course largely or wholly wasted in condensing plant. However, only from 6 to 12 per cent of the exhaust steam of an engine is needed for feed heating purposes, according as economizers are or are not employed, hence there is ample field for exhaust steam turbines. The addition of the latter to existing reciprocating plant usually effects from 20 to 40 per cent reduction in the overall steam consumption per horsepower hour and from 70 to 110 per cent increase in the total output.

A further important turbine development, of rather more restricted application, is the introduction of "combined back pressure" turbines to serve cases where, in addition to the normal power load, there is a considerable heating demand. If the latter is permanent, all that is required is a non-condensing turbine but, if the heating load is intermittent, non-condensing and exhaust steam turbine rotors may be mounted in series on the same shaft. While full heating load is supplied, the low pressure rotor merely rotates in vacuo but, as the heating load decreases, the exhaust turbine comes, automatically, into service. Suitably designed impulse turbines are as suitable as the multistage type for atmospheric working.

Canadian Hydro-Electric Power.

Figures as to the financial position of the Ontario Hydroelectric Commission have been announced by Hon. Adam Beck, chairman of the commission. The total estimated cost of the scheme was $4,006.927, and the line has been completed at a total investment of $3,921,167.97, with all interest charges paid up to November 1. As apparent from the figures, there is a balance in hand of $85,760, and Mr. Beck said that not more than one-half of this amount would be required to cover all the construction and maintenance charges for the service for the fiscal year beginning November 1, 1911, and ending November 1, 1912.

The service began with 12 municipalities taking 24,000 horsepower; today 28 municipalities have made contracts for 33,000 horsepower, and have become tributaries to the enterprise. Almost every week municipalities are voting on the power question, and the service is increasing very much more than they had anticipated, said Mr. Beck. Computing their estimates on the present consumption and on the probable new contracts which will be assumed during the coming year, Mr. Beck said they were submitting to the Government a statement that the average load of power for 1912 will be 19,470 horsepower. On this basis of calculation, the total estimated revenue of the hydroelectric service for 1912 (that is, from Nov. 1, 1911, to Nov. 1, 1912)) will be $463,828.

The total average load of power carried for the past year was 13,470 horsepower, the total amount of power paid for at the falls being 12,100 horsepower, so that enough extra power was sold to cover the cost of all line and transformer charges. Contrary to their original intention, Mr. Beck said, the charges had been made against capital instead of sinking fund for the plants installed up to November 1, next. Thereafter the levy will be made against the sinking fund. But, Mr. Beck remarked, should any municipality desire it, the commission would waive these charges against sinking fund for one or two years more so long as the charges were met in 30 years' time. Municipalities that joined the service in 1914, under the 25 years' contract, would be required to pay an interest of 2.4 instead of 1.8 under the 30 years' contract, on sinking fund.

The location of outlets in government and municipal buildings, bank and office buildings, calls for general similarity of treatment, with outlets adjacent to desks, and with ceiling outlets for general lighting and decorative effect over the general banking or public space.

Economical Effect of Increasing Vacuum on Reciprocating Engine Plant.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY C. C. HOKE, M. E.

IT is universally conceded, in power plant practice, that the higher the vacuum carried by the condensing equipment the greater the gross saving in steam and consequently in the fuel bill. It is likewise generally understood that for any given case there exists a value of vacuum at which the net economy will be a maximum, and beyond which the additional gross economy in steam on the engines will be more than offset by increased expenditure in connection with the condensing auxiliaries, either in power and maintenance costs, if the increase in vacuum be due to more circulating water or larger air pumps, or in interest and depreciation on cooling tower additions, if the gain be due to cooler circulating water or possibly of a combination of all the above items.

As a method of making comparative calculations of gross and net economy with a given load and under varying conditions of vacuum is probably not so generally understood, the writer will present an approximate general "gross economy" formula for such calculations, together with a discussion as to its development and application. Also of a method of arriving at the net economy due to any increase in vacuum, as well as the maximum economical vacuum for a given condition of plant load. As noted above, this discussion only applies to reciprocating engine plants, the effect of vacuum on the water rates of steam turbines being variable, and more or less peculiar to the design and size of the various machines.

The effect of an increase in vacuum at the exhaust outlet of an engine is to shorten the cut-off; that is, to increase the number of expansions. The problem in question hence resolves itself primarily into the determination of the relative number of expansions required for a given load under various assumed values of vacuum, and of the weight of steam represented by the difference in these expansions. This is determined as follows: Assume a given load in indicated horse power (I.H.P.) on an engine. Then we have I. H. P. equals 2PLAN/33,000, (1)

Where P is mean effective pressure (m. e. p.); L, the length of stroke, in feet; A, average net area of the cylinder; and N, the revolutions per minute (R. P. M.). It is to be noted that the average net area of cylinder, A, equals the area of cylinder minus one-half the area of piston rod, or rods, if the engine be a tandem compound with low pressure cylinder head, or equipped with a tail road.

It is obvious that for any engine, the portion 2LA/33 000 of the above equation will retain the same value under all conditions. This value can hence be calculated once for all, and is known as the engine constant. It may be expressed by the symbol "K," hence we have,

$$\text{I. H. P.} = \text{PNK, or } \text{P} = \text{I. H. P.}/\text{NK} \qquad (2)$$

With any assumed load in I. H. P. on an engine, therefore, and knowing its speed and cylinder dimensions, it is evident that we may at once calculate its corresponding m. e. p. by solving for P in formula (2). This will be the actual m. e. p., and does not take into consideration the various unavoidable losses. To arrive at the theoretical m. e. p. the actual m. e. p. as derived from formula (2) should be multiplied by the proper factor as given in Table 1, and the augumented value, P, thus arrived at should be used in the succeeding formulae.

It should be noted that in the case of compound engines the entire load should be referred to the low pressure cylinder in calculating the mean effective pressure, P.

TABLE 1. MEAN EFFECTIVE PRESSURE FACTOR.

Particulars of Engine.	Factor.
Good Corliss Engines with cylinders jacketed..	1.05 to 1.10
Good Corilss Engines with cylinders unjacketed.	1.10 to 1.25
Compound slide valve engines and high speed engines of the marine type	1.25 to 1.50

Assuming hyperbolic expansion in the cylinders, as represented by the Mariotte equation pv equals a constant,

$$\text{P} = \text{m. e. p.} = [\text{I}(1 + \log \text{R})]/\text{R} - \text{B} \qquad (3)$$

where I is the initial pressure of admission, in pounds absolute; R is the number of expansions, and B is the absolute back pressure, or pressure of exhaust, in pounds as as measured from the absolute vacuum line to the bottom of the indicator card. In other words, B equals the difference between the vacuum measured at exhaust outlet of the engine and the theoretical, or barometric vacuum, plus the exhaust port friction. For ordinary calculations B may be taken as the difference between the barometric and vacuum gauge readings.

Transposing formula (3) we have,

$$(1 + \log \text{R})/\text{R} = (\text{P} + \text{B})/\text{I} \qquad (4)$$

Substituting numerical values for the mean effective pressure (P), exhaust pressure (B), and initial pressure (I), we arrive at a value for the expression $(1 + \log R)/R$, whence R, the number of expansions, may be found by reference to Table II presented herewith. Since R represents the number of times the steam admitted per stroke is expanded in the cylinder before exhaust is reached, it is obvious that the value 1/R will represent the portion of the net cylinder volume which was originally filled with steam at the initial pressure I, per stroke. Hence, to arrive at the decrease in steam per stroke in terms of the cylinder volume, and under a fixed load condition at any value of vacuum as compared with a lower one, it is only necessary to substitute corresponding values of B in equation (4), solve for R for the two vacuum conditions, and subtract the reciprocal of the higher from the lower expansion ratio.

Thus, let R′ represent the number of expansions per formula (4) for the lower vacuum, and R″ that for the higher vacuum condition. Then we have a decrease in steam at pressure I, in terms of the cylinder volume per stroke $= 1/R' - 1/R''$. Letting S represent this difference, and V represent the net cylinder volume in cubic feet, we have for any engine r. p. m., N, a gain in cubic feet steam per minute = 2NVS. The gain in pounds

steam per minute will be 2NVSw, where w is the weight in pounds per cubic feet of steam at the absolute pressure I.

Assuming twenty-four hour service on the plant, 365 days per year, and letting "g" equal the gain in pounds steam per year under two conditions of vacuum, we have,

$$g = 365 \times 24 \times 60 \times 2NVSw = 1{,}051{,}200 \times NVSw. \quad (5)$$

The corresponding saving in dollars may be deduced as follows: Let C represent the cost of fuel, in dollars per long ton; E the actual evaporation per pound of fuel fired. Then we will have the savings in dollars per year, as

$$G = (1{,}051{,}200NVSwC/(2240E),$$
$$\text{or}\quad G = 470NVSwC/E, \quad (6)$$

For a plant operating ten hours per day and 300 days per year the saving in dollars will evidently be,

$$G = (10 \times 300 \times 470 \times NVSwC)/(24 \times 365,$$
$$\text{or}\quad 161NVSwC/E. \quad (7)$$

Now the values of G obtained by use of equations (6) and (7) obviously represent gross gain or saving per year due to increase in vacuum. This will in practically every case be offset more or less by the extra expenditure required to effect this gain in vacuum, which figure must be charged against the gross saving arrived at. If to secure the given increase in vacuum involves putting into service extra steam driven condenser auxiliaries, it is obvious that the total steam consumption and the operating expenses of such units should be deducted from the gross saving derived. If, however, the increase is obtained by speeding up steam units already in service, the increase in steam required will not be the average actual water rate per I. H. P. hour, times the increase in horse power required, but will be more nearly the theoretical water rate as obtained from the indicator card, multiplied by the horse power increase. This is evident from the fact that the condensation and leakage losses on an engine are practically constant whether the unit is operating at part or full load. The latter case would of course also apply if the condenser units were driven from the engines under consideration, either electrically or otherwise. If the gain in vacuum were due to increase in cooling tower capacity or other construction work, the interest and depreciation charges on the investment required to effect the change should be deducted.

The following typical problem will make clear the method outlined above for calculating the gross and the net savings due to an increase in vacuum: A certain plant of about 5,000 h. p. capacity has an 800 k. .w and a 300 k. w. unit operating in common on a jet condenser of the barometric type. The loads carried, together with other data, are given in the table below:

Engine	Aver. I.H.P.	R.P.M.	Eng. Con. (K) L. P. Cyl.	Mean Effective Press. Actual	Theor.	Cyl. Vol Cu. Ft. (V).
800	1050	90	0.36617	31.86	35.00	41.96
300	370	100	0.14541	25.45	28.00	16.66

Barometric Pressure = 25.8″ Hg. Initial Pressure = 162 pounds Absolute. Calculate the gross and the net gain incident to increasing the vacuum on the engines from 20 inches to 22 inches by the mercury guage.

Considering the larger engine first we have, B for 20-inch vacuum referred to 25.8-inch barometer = (25.8 — 20)/2, or 2.9 pounds. Call this 3.5 pounds to allow for port friction. Then,

$$(1+\log R')/R' = (P+B)/I = (35.00+3.5)/162, \text{ or } 0.23765.$$

Hence R′ (from Table or computation) is found to be 15.84.

For 22-inch vacuum B is similarly found to equal 1.9 pounds, say 2.5 pounds total. Substituting this value we have,

$$(1 + \log R'')/R'' = (35.00 + 2.5)/162,$$
$$\text{or}\quad 0.23148, \text{ whence } R'' = 16.40.$$
$$S = (1/R' - 1/R'') = (1/15.84 - 1/16.40) = 0.002155;$$

w at 162 pounds absolute = 0.3609 pounds per cubic foot steam.

Take actual evaporation per pound coal at 7.5 pounds = E; Cost of coal per long ton (C), \$5.50. Then by equation (6) the saving per year on the 800 k. w. engine will be,

$$G = 470NVSwC/E = 470 \times 90 \times 41.96 \times .002155$$
$$\times 3609 \times 5.50/7.5 = \$1{,}015.30.$$

Applying a similar series of calculations in the case of the 300 k. w. unit we find that the saving per year due to the above increase in vacuum will be \$419.76. Hence, total gross saving per year on the plant under consideration and the given change in vacuum will be \$1,015.30 + 419.76, or \$1,425.06.

To arrive at the net saving we must deduct from the above total gross saving the extra expense incurred in increasing the vacuum from 20 inches to 22 inches. In the case in question this increase was secured by increasing the volume of circulating water on the condenser by speeding up an electric motor driven circulating pump. This motor was driven from the 300 k. w. generating unit and the increase in I. H. P. required to raise the pump speed the necessary amount was 28 I. H. P. The average water rate of this engine by a number of indicator cards was 12.05 pound per I. H. P. hour. Using this water rate, for reasons noted above, instead of the actual rate of about 16 pounds by test, we have the additional steam required per year to gain 2 inches in vacuum as $12.05 \times 28 \times 365 \times 24 = 2{,}955{,}624$ pounds, giving a cost per year of $(2955624 \times 5.50)/(7.5 \times 2240)$, or \$967.62. Hence, the net saving will be 1425.06 — 967.62, or \$457.44.

In order to arrive at the maximum economical vacuum under fixed local conditions the gross savings resulting from increasing the vacuum from any value to a number of higher values may be calculated, together with the increased expense on the condenser required to each of these increases. Curves of gross gain and additional expenditure may then be plotted, using values of vacuum as abscissae and dollars as ordinates. The curve of additional expenditure will start below the gross gain curve and finally cross this curve at some higher vacuum. The point where the two curves intersect will indicate the maximum vacuum to be carried under the load conditions under consideration, any further increase in vacuum resulting in a net loss to the plant.

In running several conduits together, a pull box will be found more economical than elbows for making turns, as one pull box will take the place of several elbows. Do not pull wires through conduits with a block and tackle, as it will not only injure the insulation, but wedge the wires in such shape that they cannot be removed readily if desired. Be careful to ream out the end when conduit is cut, as the burr may otherwise cut through the insulation. Conduits should be securely fastened to walls and ceiling by use of pipe straps or hooks. Plug all exposed ends of conduit in new buildings to prevent plaster and dirt from falling into it.

Alternating Current Engineering.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY WILLIAM R. BOWKER.

Discussion of Starting Methods for A. C. Motors, Which Do Not Involve an Auto-transformer or Resistance in Rotor Circuit.

BEFORE dealing with the method of starting an induction motor by the insertion of ohmic resistance in the coil wound rotor or secondary circuit, as an alternative to the employment of an auto-transformer or starting compensator inserted between the supply lines and primary stator circuit when the rotor is of the short circuited squirrel cage type, a full description and explanation of which has already been given, it may at this stage be advisable to briefly describe several other methods which do not involve the use of either an auto-transformer in the primary stator circuit, or an ohmic resistance or rheostat in the secondary rotor circuit.

In Fig. 64 a method of starting a motor is illustrated, the rotor being of the squirrel cage type, without the use of any external resistance in the stator circuit. This is known as the star to delta method, the primary stator circuit being wound with a delta connected winding, which at starting has the terminal connections of the winding interchanged so as to give a star combination. To attain this object the primary stator windings are brought to six terminals on the motor as shown in Fig. 64, and leads are taken to a double throw triple pole change over switch.

The stator circuit and connections of the primary winding are separately shown with the external motor connections. At starting the connections are as seen in the diagram. The change over switch is switched on to the bottom contacts, which results in a star connected stator circuit, and it will be noticed that the terminals 1-2 and 3 are joined together forming a common star connected junction. In the running position the switch is pushed over to the top contacts which interchanges the circuit connections to give a delta winding, the terminals 1 to 4, 5 to 2, and 3 to 6 being connected together. This is clearly shown in the winding circuit combination in the running position.

When in the starting position, the star connection has the effect of reducing the current per phase in the proportion of $\sqrt{3}$ to 1 as compared with the current if started with delta connection. The motor winding at starting presents $\sqrt{3}$ times the impedence to the passage of the current when connected in star. By this arrangement of motor windings at starting, there is about 1.73 times the full load normal amperes with a considerable reduction in starting torque. When the rotor has attained full speed, the switch is quickly switched over to the top contacts, which gives a delta connection, the motor then running under normal load and circuit conditions.

Messrs. Brown, Boveri & Company, of Switzerland, have reversed this condition, and utilized it in starting motors when used on mountain railways, which demand a great starting torque. The motors are wound for star connection, started in delta under load, and the current taken is $\sqrt{3}$ times greater than the corresponding star connection current, thus resulting in an increased starting torque.

A somewhat similar arrangement to Fig. 64 is shown in Fig. 65, for the connections for starting a three-phase motor. As in the previous case, the phase winding of the primary stator circuit are not permanently jointed together, but the six free ends of the three-phase windings are brought to six terminals located on the motor frame, which are connected to the double throw change over switching device as shown and in which three of the leads are arranged for star connection at starting and switched over to give a delta connection for normal running.

By this arrangement a starting voltage is secured equivalent to 57.8 per cent of the normal full line impressed running voltage, which results in a reduced starting current and torque. When starting, the switch is on the bottom contacts and in the running position, on the top contacts. Figs. 66 and 67 illustrate a method of starting a three-phase and two-phase induction motor respectively. Each is of the short circuited squirrel cage rotor type, the arrangement is claimed to be superior to using either an auto-transformer or starting resistance in the primary stator circuit. The scheme necessitates extra windings in the primary stator core slots, for the purpose of starting, being wound in the same manner and distribution as the running coils. To attain this object the connections are brought to two sets of terminals, one for starting and the other for running.

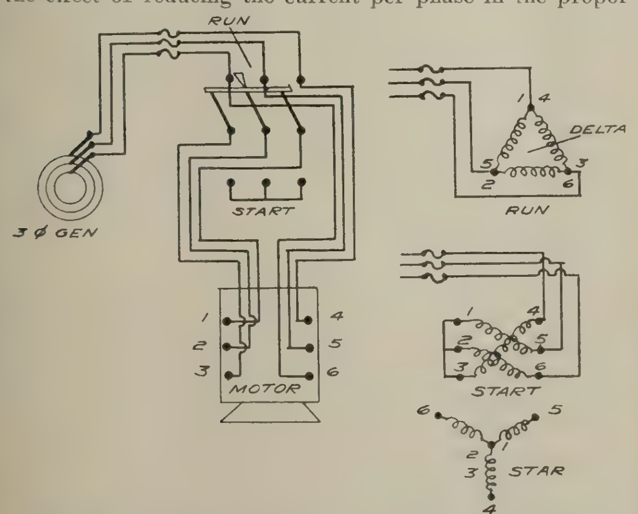


FIG. 64. THREE-PHASE STAR TO DELTA CONNECTION.

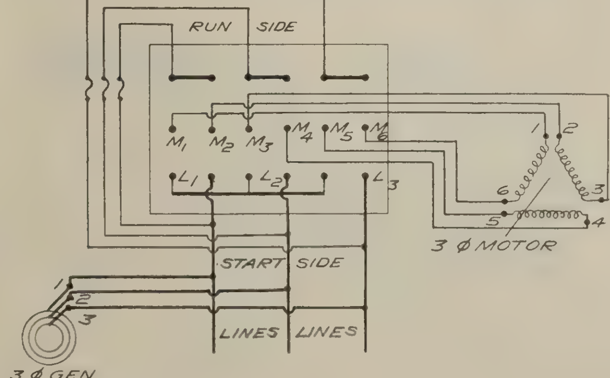
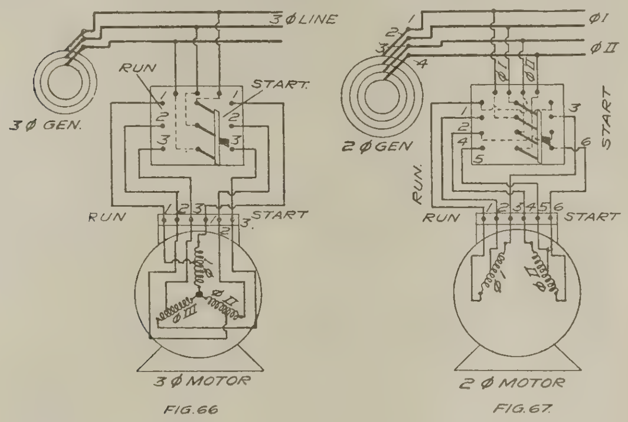


FIG. 65. ARRANGEMENT SIMILAR TO FIG. 64 FOR 3-PHASE MOTOR.

In the three-phase motor, a triple pole double-throw switch interchanges the connections and in the case of the two-phase motor, a four-pole double-throw switch is used. Provision is made so that the number of turns in the starting coils can be selected to suit the motor, and the conditions under which it will start so that the starting current and torque are under control and can be varied to fulfil the service requirements.

When connected to the starting terminals, the motor exerts about one and a quarter to one and three-quarters times the full load torque and will usually carry full load with



FIGS. 66 AND 67. METHOD OF STARTING 3-PHASE AND 2-PHASE INDUCTION MOTORS.

about 15 per cent slip. After fully speeded up and switched on to the running terminals, the slip under normal conditions varies from about 2.5 to 4 per cent according to the size of the motor. The starting coils are wound with the same size wire as the running coils, the resistance being kept low, but this necessitates an increased expenditure, adding about 40 per cent to the primary stator windings, about 25 per cent to the depth of the tooth and about 1½ per cent to the stator diameter. On the other hand, the only auxiliary required is a double-throw change over switch, there being no auto-transformer and attendant transformer losses. This arrangement, however, possesses no advantage over the auxiliary auto-transformer in practical operation or performance.

The rotors of induction motors are sometimes constructed with two separate windings; one of high resistance and the other of low resistance. The high resistance is in circuit and employed at starting and the low resistance when running, the latter being quickly switched in when the rotor

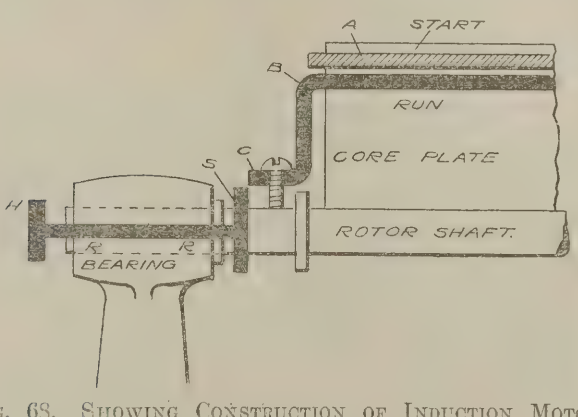


FIG. 68. SHOWING CONSTRUCTION OF INDUCTION MOTOR WITH TWO SEPARATE WINDINGS.

has attained approximately full speed. This kind of motor is very convenient where a moderate starting torque is necessary.

In Fig. 68 the principle of construction is shown in which A represents the high resistance winding permanently short circuited, and B the low resistance winding, the ends of which are connected to several contacts C, both high and low resistance windings being assembled in the same core slots. H is an insulated disk serving as the handle of a push-in switch, which acting along the rod R R presses the short circuiting ring S into contact with the several end winding terminal contacts C, thus short circuiting and forming a closed rotor winding of very low resistance.

At starting the push switch H is pulled out, thus leaving the high resistance starting winding to be wholly acted upon inductively by the stator field and current. This gives a moderate starting torque and at the same time due to its ohmic resistance presents a heavy rush of current at starting. After the rotor has attained approximately full normal speed the low resistance winding is short circuited by pushing in the switch handle H. The currents are then induced and flow in the low resistance winding, maintaining the motor in practical operation.

Although the high resistance starting winding is permanently short circuited, the current induced in it when running, is only a very small fraction of that being induced and flowing in the low resistance winding, thus the (I^2R) loss in its high resistance windings is very small and is practically of no serious moment. The windings of the short circuited squirrel cage type of rotor are in a sense fixed, that is they cannot be altered or their resistance or circuit connections changed after being assembled and completed. For this reason the voltage, current and starting torque are controlled by the previously described auto-transformers or starting compensators inserted between the supply lines and primary stator windings of the motor.

Work of Residence Business Committee of N. E. L. A.

The residence business committee of the Commercial Section of the National Electric Light Association met for second meeting on January 15th and 16th. The meeting was attended by Messrs. J. F. Becker, Chairman, G. B. Griffin, E. A. Norman, G. C. Osborne, F. D. Pembleton, and N. H. Boynton, Secretary. This committee has taken upon itself the very important work of compiling data, information and literature which will assist central station companies to increase their residence business and to make it more profitable to them. In the search for accurate data each member of the committee is doing personal work, they are also soliciting the assistance of all central station companies.

The Committee has taken up its work with the view to handling the subject intelligently and enthusiastically; with the assistance of the central station men their work will be successful. At present they are compiling information for a booklet which will be printed for use by central station companies in the direct-by-mail solicitation of residence business. This publication is to be a 24-page and cover 3 x 6 booklet which many central stations will use in their campaign for residence business.

N. H. BOYNTON, Secretary.

Determining Voltage at Distribution Center of Central Station System.

BY VICTOR C. VANCE.

(*Contributed Exclusively to* Southern Electrician.)

IN the practical operation of commercial electric plants, where plant is located some distance from the center of distribution, it is very essential on account of regulation features, to have at the central station some means of knowing at all times the voltage at the distribution center. One method of determining the center of distribution voltage is to locate an ordinary voltmeter on the board at the station with connecting wires running to the center of distribution. Fig. 1 shows the general arrangement, where D is the station dynamo; C, the center of distribution; FF, the feeders; V, the voltmeter; and WW, the pressure wires, as the wires which connect the voltmeter to the center of distribution are usually called. This arrangement involves considerable extra expense on account of having to provide the pressure wires for the voltmeter, and consequently a method in which these connections might be dispensed with, would be indeed a very desirable thing.

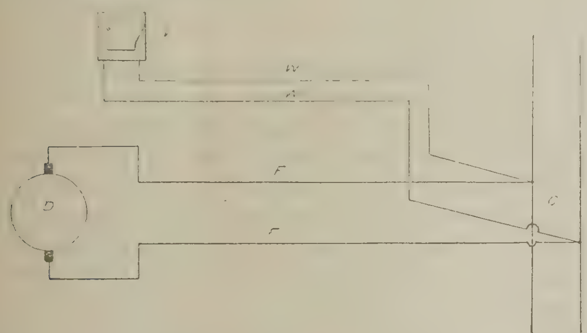


Fig. 1. Voltmeter Method at Distribution Center.

In alternating work a device that overcomes the foregoing objection is shown diagrammatically in Fig. 2. It is termed the compensating voltmeter and is in quite extensive use. Q is the compensator proper, arranged as will be observed very much like a transformer, P being the primary and S the secondary. P is divided into a number of sections with leads brought out to contact blocks as shown. The secondary S is also divided into sections with leads connecting the sections to contacts 1, 2, 3, etc. The voltmeter is at K and in this case, of the coil and plunger type. The regular coil C is supplied with current from the secondary of a small potential transformer T, with its primary connected across the mains in the usual way. Over the coil C of the voltmeter is wound a second coil R in such a way that its magnetic action will oppose that of C. Coil R is in circuit with the secondary S of the transformer. The primary P is in series with the line as may be seen. By means of the contact blocks, the adjustment of P andS is so regulated that when the voltage at the center of distribution is at its proper value, the hand H of the voltmeter will stand in a central position on the dial.

If the load should increase, thereby increasing the current and the loss of voltage in the feeders, the hand H will shift from its mid position and indicate the amount of drop of voltage at the center of distribution. The station attendant may then alter the dynamo voltage sufficiently to restore the center of distribution voltage to its normal value. On the other hand, when the load reduces, the loss in the feeders becomes so that the center of distribution voltage rises higher than normal and the hand H of the voltmeter swings from mid position in the opposite direction, a distance proportional to the rise. The principle involved in the action we have just described may be understood from the following explanation.

When the line current increases it is obvious that the primary current of the compensator Q is also correspondingly increased. This gives a proportionate increase of current in the secondary S and the coil R. This strengthens the magnetic field of R which as was previously stated acts in opposition to the magnetic field of coil C. The action of the latter is therefore weakened and core M is overbalanced by the weight W, thus pulling hand H away from the central position to the left, a distance which is calibrated to show the exact number of volts drop at the center of distribution. Again, if the load on the line decreases the current in the primary P will decrease. This will cut down the secondary current weakening the magnetic field of R. Coil C then acts more strongly on the core M, pulling it further into the coil, with a resultant swing of H to the right, which will indicate the excess of voltage at the center of distribution.

By varying the adjustment of the primary and secondary windings of the compensator, this instrument may be used with entire success on a considerable number of different lines. It, however, takes account only of the drop due to the ohmic resistance of the line, so in cases where there may be loss from reactance, its indications will not be correct.

For the purpose of taking account of the loss from reactance as well as that due to the ohmic resistance, the Mershon compensator was devised, which is a Westinghouse product. An insight into its action involves an understand-

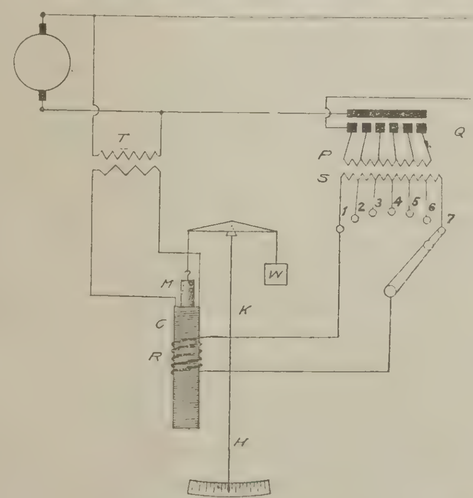


Fig. 2. Diagram of Compensating Voltmeter.

ing that the E. M. F. at the end of the line is the resultant difference between the E. M. F. generated and the E. M. F. necessary to overcome the line reactance and resistance. Then, if we can produce at the station a set of E. M. F.s which will correspond in phase with the E. M. Fs. at the center of distribution and be proportional to them, then the resutlant difference between this set of E. M. Fs. and a proportional E. M. F. corresponding to the generator E. M. F. will represent the center of distribution E. M. F. in a like proportion.

The manner in which these proportional E. M. F.s are set up at the station may be understood from a study of the diagram, Fig. 2. A is an alternator which furnishes current to the line LL; N is a potential transformer whose secondary, of course, gives an E. M. F. at all times proportional to the generator E. M. F. and in phase with it. Then, the voltmeter K if connected directly into this secondary circuit would indicate the generator voltage. What is wanted, however, is to get a voltmeter reading proportional to the E. M. F. at the center of distribution. It is necessary therefore to reduce this secondary voltage by an amount which has the same proportion to the loss incurred from line reactance and resistance as the secondary voltage has to generator

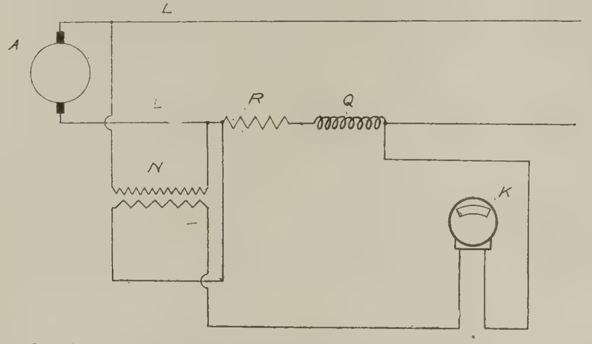


FIG. 3. DIAGRAM SHOWING METHOD OF OBTAINING VOLTAGE AT DISTRIBUTION CENTER.

voltage. Such reduction must also be in phase with the line loss it represents. This object is attained by the method illustrated in the diagram, Fig. 3. Q is an inductive, and R, a non-inductive resitance, connected in series with the line as shown. They are also connected in series with the voltmeter in the secondary circuit of N. The reactance Q is so adjusted that its inductance has the same proportion to the line inductance that the secondary E. M. F has to the generator E. M. F.; while the resistance R is adjusted to the line resistance in the same proportion.

The E. M. F. losses through Q and R will therefore be in phase with and proportional to loss due to line reactance and resistance and will suffer a corresponding rise and fall with the latter, with load changes. The second ary voltage, as stated, is in phase with and proportional to the generator voltage. The voltmeter reading is, therefore, the resultant difference between the latter and the first two, and must, therefore, be proportional to, and in phase with the E. M. F. at the center of distribution, which was the object sought.

The foregoing shows the simple principle of action embodied in the Mershon compensating voltmeter. Its actual circuits are shown in Fig. 4. Here we have the alternator and lines with the potential transformer N connected up as before. Instead of the inductance Q and the resistance R being connected directly into the main circuit as shown in Fig. 3, their place is taken by a small current transformer

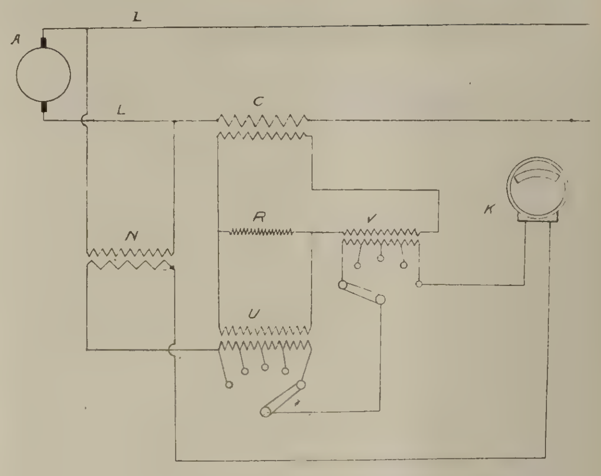


FIG. 4. CIRCUITS OF MERSHON COMPENSATING VOLTMETER.

C. the primary being in series in the line circuit while the secondary circuit includes the compensator proper which consists of two small transformers U and V. Across the terminals of the primary of U a non-inductive resistance R is connected. The secondaries of U and V are included in the secondary circuit of N, in series with each other and the voltmeter K. The E. M. F. in the secondary of N is in place with and proportional to the generator E. M. F. The secondary current in transformer C is in phase with and proportional to the main line current.

The drop of E. M. F. through the resistance R is in phase with, and proportioned to the drop in the line due to the resistance, while the drop in the transformer (or balance coil as it may be called) V is in place with and proportional to the drop in the line due to its reactance.

In transformer U the drop through the primary is the same as that previously given for the resistance K. This gives an equivalent drop in the secondary of this transformer. The combination of the secondary E. M. F. of transformer N, and the losses through the secondaries of U and V gives a voltmeter reading which is in phase with and proportioned to the end of line E. M. F. as previously explained in connection with Fig. 3. The secondaries of U and V are made in sections so that they may be adjusted to different conditions of line reactance and resistance. For use on three phase systems, two current transformers, see Fig. 5, are inserted in the line with their secondaries connected in parallel as shown. The other connections are identical with those involved in the single phase system.

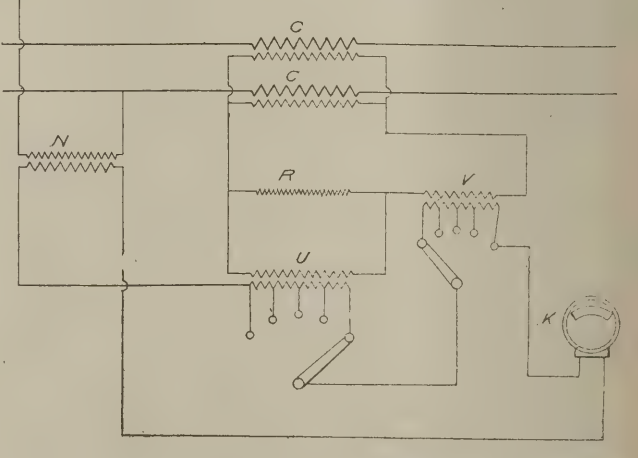


FIG. 5. DIAGRAM FOR USE OF COMPENSATING VOLTMETER ON THREE-PHASE SYSTEM.

Features of Isolated Plant Design and Operation.

BY PERCIVAL R. MOSES, CONSULTING ENGINEER.

IN referring to the design of an isolated plant, too often are many of the vital features involved overlooked by comparing it with the generating station of large size. The engineering in connection with an isolated plant should represent, if anything, a more careful consideration of details than for the larger station since the gain through its use is to be secured from the economy of operation as a whole, each part working at greatest efficiency. In view of the fact that the question of isolated plant versus central station power is of particular interest at this time in almost every central station distinct, it behooves all interested to secure all data possible, with the hope of establishing the best possible basis for deciding the adoption of either source of power in the particular cases that may come up. In what follows, information and data from an isolated plant authority in New York City is presented, abstracted from a paper presented before the A. I. E. E., on January 12 of this year.

The design of an isolated plant is seldom given the benefit of a sufficient study of the facts. There has not been the wide interchange of data from small isolated plants; operating engineers are usually too busy or too fearful to publish their results. They regard central stations as an enemy ready to shut down their plants, regardless of whether the rate obtained will pay a profit or not. Whether they are justified in this attitude or not is immaterial. The result has been to make it difficult to obtain actual data on the performance of private plants, except in the large mills and similar industrial establishments. Private plants located in buildings adjoining each other use fuel of different grades, one costing perhaps $5 a ton and the other $3. It has been equally difficult to get accurate records of loads. Few plants keep regular logs; there are many trustworthy exceptions; and the lack, until recently, of accurate and simple means of measuring the feed water supply to the boiler and the steam delivered, made it practically impossible to obtain continuous records of boiler performance. These conditions were recognized many years ago by the author, and in the plants with which he has had to do, he has endeavored to have regular logs kept, from which reliable data could be obtained on which to base design of subsequent similar plants. A number of load curves from typical buildings derived from such data sheets—log sheets—are presented herewith with the hope they may be of use to others designing plants for similar buildings.

The isolated plant, properly speaking, is a central plant for the supply of all the heat, light and power requirements of a building, while the usual central station is a central station for the supply of an isolated product. In discussing isolated plant design it is impossible to confine the investigation to the electric plant alone. It is important to realize fully that the manufacture of electricity is only a small part of the work of the isolated plant. It is one of the processes going on in a building, just the same as refrigeration, heating and the moving of the passengers. The parts are interlinked and interdependent, and with the increase in size and complexity of the modern building and the consolidation of adjoining buildings, this interdependency and interaction becomes more and more important.

The various factors that occur in the design of this isolated plant are the following: (1) Heat must be supplied to keep the building warm and also to warm the air supplied for ventilation. (2) Basement, first floor and sub-basement have to be very completely ventilated, and as no radiators are permitted on the first floor, the ventilation and heating for this floor are combined. It is particularly important that the air supplied shall be clean and free from dust. (3) The building must be equipped with sprinklers, and a complete system of fire protection provided. (4) Water must be pumped and supplied to all toilet rooms, offices, to a number of other locations, as well as to fire standpipes and sprinkler equipment. (5) Passengers must be carried to and from the various offices and lofts, and a special service of a different class must be furnished for the stores' customers. (6) A fur storage room, 50 by 60 feet (15 by 18 m.) and 13 feet (4 m.) high, must be kept at from 20 to 26 degrees Fah. by the circulation of dry refrigerated air. Filtered and refrigerated drinking water is to be provided at a number of points on each floor. (7) Electricity must be supplied for lighting large spaces and for localized illumination. Electricity must also be furnished to a number of fan and sewing machine motors, pressing irons and cutters, as well as to the large motors operating the pumps and elevators. (8) Compressed air must be supplied for elevator door operation, and the air must be exhausted for operating cash system carriers and for vacuum cleaning. The space below general sewer level must be drained and the drainage discharged into the sewers.

The source of electric supply largely determines the character of the heating system. If the supply of electricity is to be obtained from a central station, a back pressure on the steam heating system would not be objectionable, in fact a steam heating pressure variable at will is advisable; electric pumps and electric driven ventilating fans are not advisable during the heating season, but high efficiency lighting becomes even more necessary than before. The refrigerating plant should be steam driven and probably of the compression type in order to give exhaust steam, while if electricity is made on the premises, the exhaust steam available points to an exhaust steam operated absorption refrigerating plant. Motors will be planned largely for group drive with a plant and for individual drive with purchased electricity. The refrigeration design has a most important effect on the design of the water supply, as on the size and type of the refrigerating plant will depend the arrangement of water piping, the amount of storage capacity, the method of automatic pump governing and quite possibly the system of water supply risers throughout the building and the decision as to whether it will prove advisable or not to install a well. The refrigerating design will affect the power plant piping design because of the use in

the retort or generator of steam at a higher back pressure than that carried on the main parts of the plant.

The design of the ventilating equipment will be affected even if cooling of the rooms is not directly planned, because the water used on the refrigerating plant will probably be partly used for air cleansing and cooling in the ventilating plant. This independence of parts could be followed out through all the list, but sufficient has been given to show its extent.

FUEL USED FOR HEATING AND OTHER PURPOSES.

I would like to give figures of pounds of steam used to heat buildings of different types and sizes, but my facts come in dollars and tons; and it is hoped that the discussion will bring out other data.

I have not attempted to derive any formula from these figures. The facts and conditions are given, and while each case will differ from those given, the figures presented should allow an intelligent engineer or owner to estimate closely the probable cost of supplying steam to a building of one of the types given. I use the figures myself and find my estimates prove closely correct.

COST OF FUEL AND LABOR FOR HEATING TYPICAL BUILDING WITHOUT PRIVATE ELECTRIC PLANT.

Apartment Houses.

No. 1.—100 by 100 ft. (30 by 30 m.) 7 stories and basement—21 apartments—one elevator.
Steam for heating and hot water and pump. Fuel used No. 1 buckwheat at \$3.25 per ton.........Fuel \$1150 to \$1250
Labor \$1200 to \$1320

No. 2—200 by 100 ft. (61 by 30 m.) irregular—8 stories and basement—72 apartments—two elevators.
Steam for heating and hot water, laundry dryers and pumping. Fuel used costs \$2.05 per ton ....Fuel \$2350
Labor \$2276

No. 3.—200 by 92 feet (61 by 28 m.)—11 stories and basement—block front—77 apartments—elevators.
Steam for heating and hot water. Coal for heating. Coal for hot water amounted to 300 tons in a year. Stoves for dryers. Fuel used, pea coal.............Fuel \$4317
Labor \$2800

No. 4.—(Corner)—100 by 100 feet (30 by 30 m.)—12 stories.
Steam for heating, hot water dryers, refrigerating plant and pump. Used 1050 tons No. 1 buckwheat...................Fuel \$3700
Labor \$2465

I have no figures from hotels without private electric plants larger than 50 by 100 feet (15 by 30 m.) 12 stories. Almost all such hotels in New York have their own plants. Those that have not do not give out their figures.

Hotels.

No. 5—Apartment hotel. 50 by 100 feet (15 by 30 m.) 10 stories.....................Fuel \$2700
Labor \$1920

No. 6.—High class apartment hotel. 50 by 100 feet (15 by 30 m.) and annex 25 by 100 feet (7.6 by 30 m.)—4 stores.
Heating hot water and refrigeration. Absorption system. Low pressure steam....Fuel \$2503
Labor \$1920

Office Building.

No. 7—100 by 100 feet (30 by 30 m.)—12 stories—corner building.
Corner heating and some hot water.......Fuel \$1700
Labor \$2500

No. 8.—Corner—offices—11 stories—86 by 150 feet (26 by 30 m.)
Heating, steam for kitchen and refrigerating plant. Steam for hot water (25 horsepower and up) ....Fuel \$3564.65
Labor \$3746.25

No. 9.—50 and 30 by 197 feet (15 and 9 by 60 m.)
12 stories—protected on west.........Fuel \$1047.50
Labor \$2020.00

\$3067.50

No. 10.—Offices.
Steam for heating. Plunger elevators. Pumping and hot water..............Fuel \$4383.35
Labor \$5798.52

\$10,181.87

No. 11.—Offices 45 by 85 feet (13.7 by 25.9 m.)—16 stories—corner—three electric elevators ....Fuel \$1,180
Labor \$ 810

\$1,990

LOAD CURVES.

The electric load curves showing the variation in use of electricity in a number of different buildings, offer a fair basis for estimating probable requirements under similar conditions. There is a general tendency to overestimate the maximum electric demand due in great measure to the possibility of all the lights being in use at one time or of all the elevators starting at once. Practically speaking such conditions are not possible, and experience enables us to determine in advance within 10 per cent or 15 per cent what the maximum load will be for a stated size and type of building.

It is for this purpose that the load curves are particularly useful. Such load curves also aid in determining the probable kilowatt hour use per month or per year, but I find the most convenient method is to compare buildings of similar size and character. For this reason I give data on the quantities used in buildings of various types and sizes.

The curves presented herewith are taken from hourly readings, noted on regular log sheets, of which sample forms are reproduced from an office building, an apartment house and an industrial plant. The readings are, in all cases, the nearest to the steady load readable; that is, the engineer waits until the cessation of the jump caused by an elevator or several elevators starting before noting the current. Probably the readings usually include some of the running current, because while there are many periods even in a busy building when the elevators are not drawing current these intervals are infrequent and hard to catch.

DISCUSSION OF LOAD CURVES.

Load curves 1 and 2 show the variation in electric load in two apartment hotels. No. 1 is a hotel catering mainly to high class permanent residents, built on a plot 50 by 200 feet (15 by 61 m.)—12 stories and basement—contain-

ing four electric elevators, 10-ton refrigerating and ice-making plant, the usual kitchen steam-using appliances, but no laundry. The hotel has 300 guest rooms and 200 baths, hence the demand for hot water is an important factor. All the water used is pumped to a tank above the roof. There are about 1,000 outlets for lights and the total connected capacity is about 100 kw., excluding elevator motors. The elevator load which is extremely variable is equalized by a storage battery. The hotel has had its own plant for over seven years, abandoning central station supply. The maximum load occurs from six to eight o'clock p. m. and is about 100 kw. This includes about 20 kw. charging current.

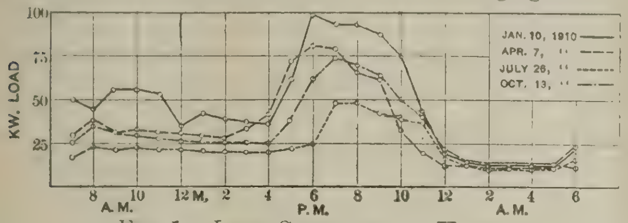


FIG. 1. LOAD CURVES FOR A HOTEL.

The ratio of maximum load to connected capacity is therefore 80 per cent. This ratio is very high because the number of outlets installed is restricted to the minimum requirement consistent with sufficient light.

Curve 2 shows the conditions in another hotel, a large imposing structure covering a block front in New York City which is 17 stories above ground and two below, built on a plot approximately 210 by 205 feet (64 by 62.4 m). This building contains housekeeping apartments, as well as the ordinary hotel rooms, restaurant kitchen and laundry. Refrigeration is supplied to the housekeeping apartments as well as to the kitchen and restaurant, and cooled drinking water is also circulated throughout the building. The elevators (about 17) are all of the hydraulic plunger type, operated by compound and triple pumps. The ground floor contains a number of handsome stores, brilliantly illuminated, while the rest of this floor is given up to public rooms and restaurant.

The approximate connected capacity of lighting is 750 kw. and the maximum load is 450 kw. from 6 to 8 p. m. The ratio of maximum load to connected capacity is therefore about 60 per cent. In this hotel the electric plant seldom used over 300 h. p. during the day and 600 horsepower at night, whereas the boiler horsepower developed frequently exceeds 1,000. The balance is made up of the steam supplied to elevator pumps, half a dozen other steam pumps, laundry, kitchen and refrigerating plant. During the cold weather the exhaust steam from all the apparatus does not suffice to heat the building, and additional boiler steam is

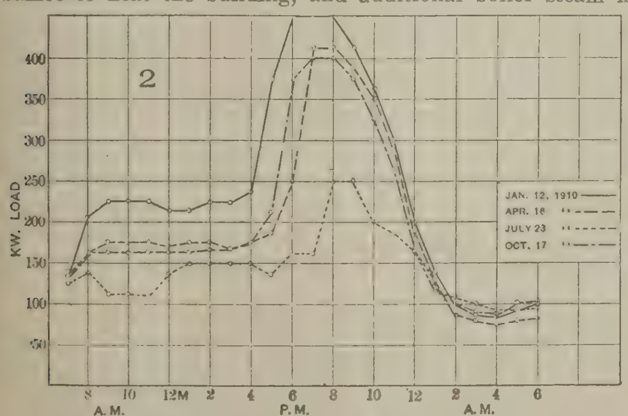


FIG. 2. LOAD CURVES FOR AN APARTMENT HOTEL.

needed. It is not unusual in the building to burn 40 tons of fuel in a day, and 50 tons have been burned in extreme weather. This latter consumption indicates an average of 1,000 horsepower for the whole 24 hours. During the cold season it is evident that the electricity is really a by-product

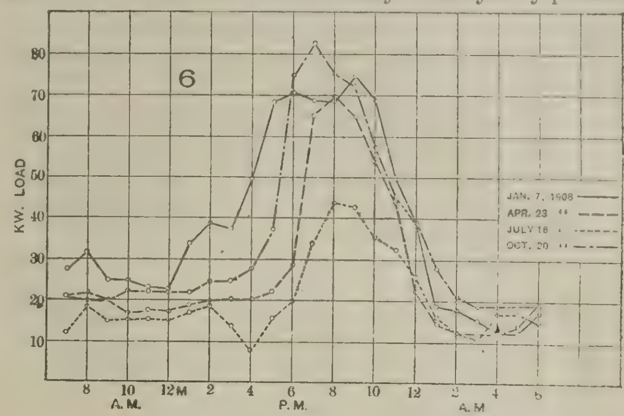


FIG. 3. LOAD CURVES FOR AN APARTMENT HOUSE.

of the heating, insofar as the fuel is concerned. A distributive test showed that the electric plant used about seven-eighteenths of the total steam supplied.

Curve 3 shows the electric load variations in an apartment house of the best grade. The apartments are of from five to fourteen rooms, rented at from $1,000 to $5,000 per year. They have artificial cold storage, complete porter service and vacuum steam heating system among the "modern improvements." There are seven electric elevators for eighty-seven apartments. Electricity is made on the premises, but it is sold to the tenants at the regular central station rate after being metered. The connected capacitiy exclusive of elevators is over 200 kw. and the maximum load is 75 kw. The 82-kw. load on October 20, 1908, was due to special decorative lighting. As this 75 kw. includes about 12 kw. battery charging current, the ratio of maximum to connected load is actually about 30 per cent. The effect of metering is clearly indicated if the ratio of maximum load to connected load, 70 per cent is compared with this ratio of 30 per cent.

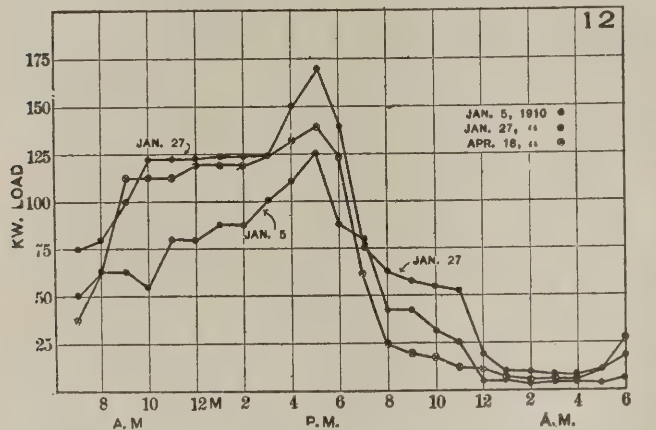
Curves 4 and 5 are from typical office buildings. Curve 4 taken January 27 and April 18, includes the electricity supplied to a 12 story building 50 to 100 feet (15 by 30 m.), abutting into the south. (January 5 curve covers the original building only. This building contains five elevators and the abutting building contains three. These are supplied through a storage battery and the load curves include about 25 kw. of charging current. The ground floor basement is occupied mainly by a restaurant and a store. A very complete electric-driven ventilating equipment is installed for both of these. Curve 5 is from another office building on a corner 100 by 100 feet (30 by 30 m.) and has four elevators but no storage battery. This load curve shows steady load as nearly as possible. The connected capacities are 375 kw. and 212 kw. respectively and the ratio of maximum load to connected load is 44 per cent and 26 per cent. The connected capacities are 375 kw. and 212 kw. respectively and the ratio of maximum load to connected load is 44 per cent and 26 per cent.

LOAD CURVE CHARACTERISTICS.

The electric load curves of the hotels show a daily running load from 8 a. m. to 3 p. m. of from one-quarter to one-third the maximum load, and a peak load from dusk to midnight or 11 p. m. of from one-half to full maximum

load, depending upon the season. The apartment houses where electricity is paid for, show a day load, deducting charging current of from 1/7 to 1/8. The maximum load with the usual peak from dusk to 11 p. m. of about 3/4 maximum load, except in summer when it falls to one-half. When light is included in the rent, the day load varies from one-seventh to one-third the maximum, and the peak load except in the summer is about three-quarters of the maximum.

The department store shows a steady day load from 9 a. m. until 4 p. m. in the winter; and until closing time in the other seasons of about two-fifths; the maximum load and the night lighting for cleaning, etc., vary from one-fifth to one-tenth the maximum.

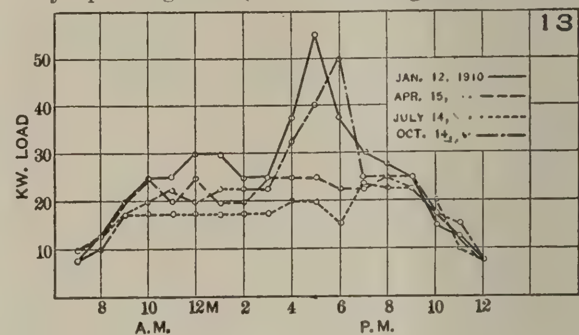


The office building without restaurant has a day load of from one-third to two-fifths the maximum load, and there is no peak except during the winter and fall months. The office building with restaurant and ventilating fans has a day load of about two-thirds the maximum, and the peak load lasts about two hours. The manufacturing loft building has a steady load except during the noon hour of three-quarters to seven-eights of the maximum. The lesser load during the summer months in one case is due to the stopping of the printing plant. The peaks seldom last longer than one hour. The industrial plants have similar curves, i. e., steady load with comparatively small peaks for about an hour.

With these load curves and others, as a basis for design, the division of the isolated plant into suitable units is not difficult, if the probable tendency of the building can be gaged in advance. In the following discussion, a unit is intended to mean an engine dynamo, with its switchboard, piping and accessories. For a hotel or apartment house a three unit plant, each unit having a capacity of half the maximum demand, will leave one unit always in reserve; one will operate the equipment during the light load periods, and the two during peak load with good over-all efficiency and perfect reliability. If electric elevators are installed, a storage battery to equalize the fluctuations while the dynamos are operating and to carry the small lighting load from 1 a. m. until 6 p. m. while the dynamos are shut down is a valuable and advisable adjunct, not only as an economizer of fuel, but also to insure freedom from voltage variation.

In large plants like that of the hotel illustrated in Curve 2, it may be advisable to make the plant a four-unit plant, two of the units having each one-sixth the capacity required for the maximum demand. One of these operated after midnight will then supply all the service. In the loft and manufacturing buildings, two large units, each capable of carrying the full load, and one small unit for after-hour service, is advisable unless the fixed charges on the extra initial cost of the two large units over a three-unit plant with each unit equal to one-half the maximum demand, more than equals the saving obtainable by the operation of one unit instead of two. As the cost of the two-unit plant is usually at least one-quarter more than the three-unit plant, this question requires careful consideration, but simplification and space conditions point *apriori* to the two-unit equipment.

The same conditions hold with department store equipments, but another factor of grave importance enters, viz., continuity of operation. Darkness in a department store during a busy season might cause a panic and would almost certainly mean loss, hence it is advisable to have two units actually operating during all the selling time, or at least



Figs. 4 and 5. Load Curves for Typical Office Buildings.

during peak load period, so that if anything should occur to prevent one machine from supplying light, the other would be immediately available. Hence it is customary and advisable to have at least three large units and one small one for late night service. Office buildings of the ordinary type come under the same grouping as the hotels and apartments. The peak is of much shorter duration, and one of the units may be of less efficient type than the two regularly operated engines, if the size of the plant makes such a distinction advisable.

A storage battery is particularly advisable in most office buildings that are equipped with electric elevators, because the elevator load is a very large and sudden addition to the regular running load, and even with the perfected modern mechanical and electrical governors, some fluctuation in the lights is liable to occur. Of more importance in this connection is the small but necessary night lighting and the power required for a night watchman's elevator service, for both of which the storage battery is admirably adapted. For factories occupied by a single owner, a single unit plant is adopted in most instances, because of its simplicity and the usual reliability of the slow-speed engines and dynamos ordinarily adopted for such installations. Such an equipment has its serious drawbacks, particularly in starting a new plant, where some unforeseen and hidden trouble in manufacture may cause untold annoyance, if it develops after the regular running is commenced. If ample time can be had to test out the apparatus beforehand, little trouble need be feared with a single unit where the schedule of 10 or 11 hours a day is adhered to.

If heating is a negligible matter, as it is in tropical countries and in many manufacturing and industrial establishments, the choice of a prime mover is governed by the balance between investment and efficiency. The high efficiency modern producer gas engine and the oil engine by their sim-

plicity and reliability offer many advantages over the high pressure steam plant, and where steam is not used for other purposes to an extent proportioned to the power requirements, the tendency is rightly toward this type of plant. Two producer gas engine plants recently installed have given results fully equal to the guarantees, and a kilowatt hour can be and is regularly produced at the switchboard under regular operating conditions for about two pounds of No. 1 buckwheat anthracite or pea coal, and this in plants of a few hundred kilowatts capacity.

In many instances a combined steam engine and producer gas or oil engine plant offers the best solution, the steam plant being installed to such extent only that its exhaust may be fully utilized. With such equipments, with the exhaust gases from the gas engine used to heat feed water from the boilers, an almost ideal operating condition exists for at least part of the year.

COSTS OF MAKING ELECTRICITY.

Some kilowatt-hour costs in buildings follow: These costs are derived by deducting from the total operating cost of the building with an electric plant, the cost of operating without an electric plant. This latter cost is either actual or estimated depending upon whether street service had been used prior to the installation of the private plant or not. In each instance the fact is stated. I do not go into particulars of each plant because there have been many such figures printed. They are, however, as closely correct as I can make them and are taken from the regular monthly plant reports. Where the costs are given for different seasons, the variation is due of course to the high cost of supplying heat and engineers services, etc., during the winter and the relatively low cost of these services during the summer. The kilowatt-hour costs do not include fixed charges unless otherwise stated. Fixed charges are excluded because each case presents a different condition. Money may be worth 25 per cent to one man and 3 per cent to another. With the cost of making the electricity before him, each man can then decide if this cost is sufficiently less than the central station charge to warrant the investment.

KILOWATT-HOUR COSTS

Loft building.—100 by 100 ft. (30 by 30 m.) 12 stories and basement.

Month	Kw-hr.	Total cost	Basic cost	Mfg. cost	Mfg. cost per kw-hr.
April	15080	756.81	300	456.81	$0.03
January	18450	936.26	470	466.26	$0.0252
October	17810	884.76	300	484.76	$0.0328
July	12060	680.26	200	480.26	$0.04

Cost of plant: $12,000. Fixed charges per kw-hr. approximately ¾c.

Loft building.—185 by 200 ft. (56 by 61 m.) 12 stories and two basements.

Month	Kw-hr.	Total cost	Basic cost	Mfg. cost	Mfg. cost per kw-hr.
April	36930	1830.25	750	1080.25	$0.029
January	41950	1841.82	950	891.82	$0.0212
October	39480	1643.07	750	893.07	$0.0226
July	31800	1543.04	650	893.04	$0.0281

Fixed charges: ¼ cent per kw-hr. Plant cost, $20,000.

Apartment house: (free light); 36 apartments, high class refrigeration; best service.

Month	Kw-hr.	Total cost	Basic cost	Mfg. cost	Mfg. cost per kw-hr.
April	17450	1359.86	1016.85	343.01	$0.0197
January	21620	1360.84	1052.29	308.55	$0.0142
October	13500	1208.67	900.75	307.92	$0.0228
July	9350	1074.03	709.82	364.21	$0.0389

Apartment house: (Electricity sold to tenants; 87 apartments; high class refrigeration; best service; large quantity public lighting.

Month	Kw-hr.	Total cost	Basic cost	Mfg. cost	Mfg. cost per kw-hr.
April					
January	18154	2224.59	1749.18	475.29	$0.0261
October	14885	1920.56	1507.34	413.22	$0.0278
July	11254	1731.54	1226.66	504.88	$0.045

These items are all higher than usual because last year the plant was completely overhauled, new plates installed in storage battery, new condenser for refrigerating plant, new hot water tank, etc., all of which is charged off during ten months from date of expenditure.

Office building: 100 by 100 ft. (30 by 30 m.) 12 stories; tungsten lighting; four elevators.

Month	Kw-hr.	Total cost	Basic cost	Mfg. cost	Mfg. cost per kw-hr.
April	14600	738.15	365.62	372.53	$0.026
January	18310	714.39	458.40	255.99	$0.0142
October	15060	669.69	355.03	314.66	$0.021
July	11590	693.17	250.00	443.17	$0.04

Office building: 140 by 70 ft. (42.6 by 21 m.) 10 stories.

Total kw-hr. 340,000 of which 88,817 were used mainly for driving an electric pump for operating two high-speed plunger elevators. 255,788 kw-hrs. for lighting.

Total cost per year	$8,070
Basic cost (estimated)	$3,200
Cost of electricity	$4,870
Manufacturing cost per kw-hr	1.43 cents

MANUFACTURING PLANTS

Locomotive Works—oil engines.

Total cost per kw-hr. on 225 h.p. set (including 0.223 cent for fixed charges) ... 0.74 cent.

5300 hours a year at full load.

Shop time 6500 hours.

With load factor another year after panic, of only 24%, cost per kw-hr. was increased to ... 2 cents.

TABLE OF COST PER KILOWATT CAPACITY

(Based on personal experience in New York and vicinity)

	Per kw. of plant capacity
Boilers (erected and set in masonry):	
Horizontal-tubular	$14—$18
Water-tube	16— 20
Steam engines:	
High-speed, simple direct-connected	20— 25
Medium-speed, compound non-condensing direct connected	28— 35
Low-speed, compound condensing, belted	20— 25
Low-speed, simple, belted	25— 30
Gas engines	50— 60
Oil engines	75— 85
Gas producers	15— 20
Dynamos:	
Direct-connected to high speed engine	13— 16
Belt-connected to engine	12— 15
Direct-connected to corliss engine	16— 20
Switchboard	5— 10
Foundations	5— 10
Steamfitting—including auxiliary apparatus—such as feed heater, grease separator, exhaust head, tanks, covering, etc	20— 30

Economy in Telephone Pole-Line Construction.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY ROY C. FRYER.

WHEN telephone lines were first built, the most approved way of putting up the wires was to give a couple of helpers, a bail of wire, instruct a lineman to go up pole No. 1, and make the free end of the wire secure. The two helpers would then walk past post No. 2, and lineman No. 2 would ascend this post, pull up the slack with his belt vise, and tie the wire in, while during this time the first lineman would be on his way to pole No. 3. When things were all working properly, they could make considerable headway, sometimes employing several linemen all working upon the same strand. This method is still used with good success, when stringing only an additional line, with a deck or so of wires that has been installed for some time.

There are at present over twenty thousand telephone companies in the United States. Think how many thousands of miles of wire is required to transmit the messages of these companies. Think how many men and how many days would be required to build these lines in the section at a time way and of the reduced cost, in time saved by running these wires by the deck instead of by the strand. At the present time instead of a lineman tieing in one strand in each trip up the pole, he ties in perhaps four, six or ten. Providing the lines to be built have been properly laid out by a competent telephone engineer, the effort to save material by the Superintendents of Construction, will be less fruitful, than if the line is built by experience instead of by survey.

The point of saving material is usually looked after by the engineer in charge of the survey and layout, at least it

should be as it comes under his jurisdiction. The greatest saving that remains to be effected by the construction man then is the saving of labor, and the reduction of maintenance expense by seeing that the work is erected in a way that will remain substantial, that will lend to convenience, and that will have a good appearance. To have a good sytem worked out, and to adhere to it will perhaps reduce the cost of labor more than any other one thing.

The writer has been where construction work was going on, when bystanders made the remark that all the men were not employed all the time, thus causing a waste. It is true that on first inspection, this looks to be perhaps the case, but it is often exactly the opposite. Each man should have his regular duties to perform, and should be selected for the duties that he is most capable of performing. Then when he is through, if he has been properly selected to fill the place, and the rest of the corps have been selected properly for their work, none will have to wait long for the other, and none should be expected to help the other. In raising poles, if a man uses first the pike, and then the cant hook, when he drops one to use the other, it will probably be several feet from him, and in reaching to get it the pole may slip and some one may be hurt or at least useless time consumed, because each man did not have his work to do, and do it promptly.

Right here there comes to mind a point which is hard in some cases to decide, and that is to detect where the saving of labor sometimes infringes on the quality of construction, and in lessening the quality of construction, eats up the profit on the labor saved. Sometimes, and often, an hour extra spent upon some work will pay, and pay well. When a plant is expected to last fifteen years, a saving of six and two-thirds per cent per annum, will rebuild the plant at the end of that time, and if this six and two-thirds per cent is laid away year after year, as it should be, at the end of the fifteen years, the stockholders will not be taxed again to rebuild the plant. Please bear in mind the difference between repairs and depreciation. The expense of repairs should be held separate over and above this per cent.

In order to prove that an hour extra will sometimes pay a large dividend, let us say that we are to erect a plant, the poles of which shall cost one thousand dollars. The charges we should lay back yearly if we expect this line to stand for fifteen years would amount to $66.67 per annum.

Let us take extra pains in setting these posts, to see that the earth is tamped very solidly around their base, and that there is made a mound of dirt about one foot high around their base and slanting out a foot or two from the bottom of the pole. This will take but a few minutes, but if the entire line is built this way, fewer poles will fall, and the average life of the pole line will be increased about one year, at least, over the life of a line that is set without proper tamping and mounds to exclude the water from around the poles, causing rotting more quickly, and costing more of the trouble shooter's time.

If we gain one year's life, the line will evidently stand for sixteen years instead of fifteen years. If the charges for depreciation amount to six and two-thirds per cent per annum with fifteen years' life, the charges per annum for a plant that will stand for sixteen years will be at the rate of six and one-fourth per cent. The difference between six and one-fourth per cent and six and two-thirds per cent is five-twelfths of one per cent. If the initial cost is one thousand dollars, one per cent will be ten dollars, one twelfth of one per cent is eight-three and one-third cents, and five-twelfths is four dollars and seventeen cents, the saving per year in the difference in depreciation charges. The line standing for sixteen years, the saving will be sixteen times four dollars and seventeen cents, which is sixty-six dollars and seventy-two cents the total saving on a small line. This does not look very large, but this is only on one thousand dollars' worth of property. If your plant is worth ten thousand dollars, look after other numerous little items that will increase the life of your plant one year or over, and then you can multiply these figures by ten, giving you a saving in depreciatory charges only of six hundred and sixty-seven dollars and twenty cents, and the man who will scorn this amount in a business whose toll is taken in, in the sums of ten and fifteen cents, will never make a thorough success in the telephone business.

So far as we have only considered the saving in depreciation on the capital invested. We have not stopped to notice that a pole well set will not cause as much trouble on the line, and we have stopped to notice that there are numerous law suits against telephone companies when poles or lines fall across the highway, and endanger the traffic. Very few lines that are constructed on the principles of a few years ago, will stand a severe storm without developing some trouble. Let us say that we are to prevent half the trouble, by increasing the life of the line, and by making it more substantial. The saving in your trouble man's expense should amount to one-fourth his expenses. This would be probably in the neighborhood of one or two hundred dollars per year, but to be conservative let us estimate it at fifty dollars per year on the entire plant and in sixteen years this will make an additional saving of eight hundred dollars, or a total saving on the entire plant, by watching almost what seems to be the infinetesimal things, of $1,467.20. In general a good moral for telephone men is to watch the small things.

Big Men Active in New York Jovianism.

The bi-weekly lunches of the New York Jovians continue to reap an attendance remarkable both for its size and for the importance of the men attending. On January 24th, T. C. Martin, secretary of the N. E. L. A., Frank Frueauff, general manager of the Denver Gas & Electric Light Company, H. H. Scott, of Henry L. Doherty and Company, and Philip S. Dodd, secretary of the commercial section of the N. E. L. A. were among those seated at the speaker's table. In addition, practically every large electrical interest in the city was represented by from one to a dozen of its executives and department heads, the total attendance being about 165.

The speaker of the day was Professor J. W. Jenks, who occupies the chair of economics at Cornell University. Prof. Jenks spoke of the economic aspects of the recent tobacco and Standard Oil decisions of the Supreme Court. He pointed out that both the public and politicians are prone to make fetiches of phrases and he analyzed for the benefit of those present such recurring words as "competition," "freedom of opportunity," "monopoly," etc., explaining that our definition of these forms must necessarily change with the progress of the country and that to apply the definition of a few years ago to the condition of today may be good law but bad economics.

Announcement was made by F. E. Watts, Jovian statesmen for New York of the Rejuvenation which was held at

the Hotel Astor on February 7th. It was announced that some sixty applicants for membership had been received and that fully one hundred new members were expected at that Rejuvenation.

Jovian Banquet in Honor of Walter M. Stearns, at Atlanta.

On Feb. 3, 1912, Atlanta Jovians gave a banquet at the Capital City Club, in honor of Walter M. Stearns, assistant district manager of the Atlanta office of the General Electric Company and the Hercules of the tenth Jovian Congress. The banquet was very quietly worked up by Mr. F. M. Byrne, statesman at large for Georgia, and attended by a large number of Atlanta's most influential Jovians. Mr. Stearns has been a Jovian since January 29, 1910, and been active in building up the order to its present position in Atlanta. It was in recognition of this work and his personal interest in everything that Jovianism stands for, that the banquet was given.

The officiating Jovian of the evening, acting as toastmaster and injecting the altogether spirit into the gathering, was Mr. W. R. C. Smith, faimliarly known as the "old man himself," in connection with the W. R. C. Smith Publishing Company, the home of SOUTHERN ELECTRICIAN, *Southern Engineer, Southern Macchinery and Cotton.* Through a wise selection of speakers, Toastmaster Smith brought out the biography of Mr. Stearns from the date of leaving Boston School of Technology, through a sales experience with Fort Wayne Electric Works and managership of the Atlanta office of that company, up to his present position as assistant to Mr. Giles in one of the General Electric Company's largest branch offices. The speaking was spirited and showed Mr. Stearn the possessor of a reputation both in business and private life, of a most enviable character. Those responding were as follows: Wm. R. Collier, contract agent of Georgia Railway and Electric Co., and a classmate of Mr. Stearns; Mr. A. F. Giles, district manager of Atlanta office of General Electric Company; W. H. Smaw, purchasing agent of Georgia Railway and Electric Co.; F. V. L. Smith, manufacturers agent of Atlanta and its Jovian of oldest standing; W. H. Adkins, general contract agent of the Southern Bell T. & T. Co.; Walter M. Stearns, Hercules; L. S. Montgomery, statesman for Georgia and district manager for National Metal Molding Company; F. M. Byrne, satesman-at-large for Georgia and manufacturers agent at Atlanta;, and J. J. Smith, local manager for Baltimore Electric Supply Company.

Electrical Show at Georgia School of Technology.

The second annual electrical show held by the Georgia School of Technology at Atlanta, Feb. 9, 1912, proved even more successful than the one of last year. So well was it attended and so complete the displays, it has created an interest which has assured its continuance annually as one of the important events at the school. The moving spirit of the electrical show was Prof. H. P. Wood, Dean of the Electrical department, and in regard to it he has the following to say:

"I regard the recent show as of great educational importance to our students. The management of it developes a certain training in executive work and the indi-

FROM RIGHT TO LEFT IN ILLUSTRATION: W. R. C. Smith, of W. R. C. Smith Pub. Co., Toast-Master; L. S. Montgomery, Statesman for Georgia, National Metal Molding Co.; W. H. Adkins, Gen. Contract Agent, Southern Bell Tel. & Tel. Co.; Walter M. Stearns, Hercules, General Electric Co; Wm Rawson Collier, Georgia Railway & Electric Co.; T. W. Moore, General Electric Co.; W. H. Smaw, Georgia Railway & Electric Co.; L. L. Shivers, W. E. Carter Elec. Co.; J. W. Gibson, Southern Bell Tel. & Tel. Co.; Geo. F. Schoen,; R. H. Park, C. B. McGaughey Elec. Co.; C. B. McGaughey, C. B. McGaughey Elec. Co.; A. E. Salling, Contractor.; H. B. Thrash, W. E. Carter Elec. Co.; G. E. Russell, Russell Elec. Co.; J. W. Little, Russell Elec. Co.; F. V. L. Smith, Manufacturers' Agent; T. R. Salley, Western Elec. Co.; A. F. Hammond, W. E. Carter Elec Co.; W. L. Vailey, Gate City Elec. Co.; P. R. Moffett, Electric Storage Battery Co.; Dan W. Bowie, Asst. Supt. Elec. Affairs City of Atlanta; W. C. Spiker, Consulting Engineer; W. W. Henry, Georgia Railway & Elec. Co.; L. E. Moncrief, Manufacturers' Agent; T. H. McKinney, Peters-McKinney Elec. Co.; W. C. Hicks, Franklyn Elec. & Mfg. Co.; G. L. Cantrell, Gate City Elec. Co.; J. J. Smith, Baltimore Electrical Sup. Co.; F. M. Byrne, Manufacturers' Agent; A. F. Giles; General Elec. Co.; Forrest Adair, Financier of Atlanta.

vidual men have to exercise some originality in preparing their exhibits The show differs from the ordinary electrical show in that it is not merely a display of apparatus but is a working demonstration of apparatus and of electrical principles. We have 28 men taking the Electrical Course in our Senior class and everyone had an exhibit of some kind. In addition we had Dr. W. A. Jackson with an X-ray outfit, Dr. Perryman of the Perryman Company with an exhibit of medical apparatus and demonstration of the same, and Mr. H. W. Karstens of the Holophane Co. who gave a series of thirty minute lectures on the proper use of reflectors in residence and industrial lighting. An exhibit was also given of the Pyrene fire extinguisher for putting out fire started by electricity in which an electric arc between copper and carbon was extinguished at intervals and a series of small lights and a motor were submerged in Pyrene and kept working to show the non-conducting nature of the liquid.

"We had two X-ray outfits at work continuously and should have had twice the number to give everyone a chance to see his bones. The familiar stunt of cooking on ice was performed as an illustration of the principle of induced currents. A 10,000 volt arc was repeatedly drawn and allowed to ascend two parallel wires until at the top it was broken by a horn gap. A striking and instructive exhibit was performed in connection with the electric welder. About four turns of number eight copper wire were connected on the low voltage side and heated to a red heat by the passage of the current. Iron filings when sprinkled on this coil curled around it in a striking manner and showed the circular magnetic field. After a short time when they became heated sufficiently they dropped off showing the loss of magnetic quality in red hot iron. The electro-plating of objects such as fruit attracted much attention. The precipitation of smoke by electrostatic charges worked successfully."

The show was given by 28 members of the senior electrical class, supervised by Prof. H. P. Wood, dean of the Electrical department. Managers of the show were D. W. Harris, general manager; W. H. Lamar, treasurer; E. H. Hubert, and R. D. Conacher, advertising managers, and W. A. Smith, chief engineer.

Merger of Wire Inspection Bureau with the Underwriters' Laboratories.

On November 15th, 1911, and after several conferences between representatives of Underwriters' Laboratories and Rubber Covered Wire Manufacturers, an agreement was reached for the re-establishment, after January 1st, 1912, of a single label factory inspection service, operating under the new 1911 National Electric Code Specifications. This service represents a merger of the Wire Inspection Bureau Service on National Electric Code rubber-covered wire with that of the Underwriters' Laboratories, Inc., and will be under the direct operating control of the latter organization, and is based on specifications and procedure representing the best thought of the Underwriters and the rubber covered wire manufacturers. The procedure under this service is not only very thorough at factory, but also contains a rigid follow-up system in the field, and can hardly fail to be much more productive of results than anything in this line which has so far obtained.

As the merger referred to is one of public interest, a full account of what has actually been done and the reasons for the same will when given out appear in these columns. It is reported that manufacturers are now equipped to make up the new code 1911 wire and there need be no fear but what ample quantities will be furnished to supply any requirements. The ne wservice is a logical sequence to the original Wire Inspection Bureau Service started in 1905, and represents experience gained during the last several years by practically all parties at interest. And it has for its object to prevent the introduction and use of any wire inferior to the Standard of the National Board of Fire Underwriters new 1911 rubber-covered wire specifications. This to prevent as far as possible the further use of wire with defective rubber insulation. Wire meeting the specifications, as evidenced by inspection and tests, will bear stamps of the Underwriters' Laboratories, Inc., varying from 100 feet to 1,000 feet and similar to those now in use.

The majority of Rubber Covered Wire manufacturers have agreed that on and after January 1st, 1912, all new National Electric Code rubber-covered wide manufactured by their companies will be duly tested under the new specifications, and will bear the identification label of the Underwriters' Laboratories, Inc., as evidence of its conformance to these specifications. It is understood that a reasonable time will be allowed after this date for the disposal of old Code wire not bearing this stamp of approval and representing bona fide stock or contracts placed or taken prior to January 1st, 1912. This with the assumption that such stock or contracts of old Code wire will be entirely disposed of by July 1st, 1912, and that after such later date, only the new specification 1911 wire will be accepted as Code wire by those authorities having jurisdiction.

Notice to N. E. L. A. Delegates to Seattle Convention.

A letter has recently been received from Mr. A. P. T New Business Manager of the Northern Idaho and Montana Power Company, Kalispell, Mont., which will be of interest to all planning to attend the next N. E. L. A. convention. The letter follows:

"I am enclosing herewith a notice to the delegates attending the N. E. L. A. convention at Seattle in June. Due to the fact that a large number of these delegates have to pass through our country, a great many of them not being familiar with the important and scenic parts in the northern part of the State of Montana, I request that you print in the next publication of the Southern Electrician the notice herewith enclosed. By so doing you will confer a great favor to one of your subscribers.

"To N. E. L. A. Delegates: On your return from the N. E. L. A. Convention at Seattle, in June, we would be pleased to have you stop over and explore our beautiful country, "The Switzerland of America." Trout fishing in every stream, and the most delightful climate in the world, therefore, we extend to you a hearty invitation, and you will find the N. E. L. A. glad hand to receive you.

(Signed) Northern Idaho & Montana Power Co., Kalispal, Montana, W. B. MacDonald, Genl. Mgr., A. P. Tills, New Business Mgr."

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

TUNGSTEN VS. CARBON LAMPS.

Editor Southern Electrician:

(278) Suppose five 16 candle power lamps are to be used on an average of 5 hours per day per month, what will be the saving when using the same candle power by means of tungsten lamps? Consider life and renewals in each case over a period of one year. H. A. P.

PROPER WATTMETER CONNECTION.

Editor Southern Electrician:

(279) Please insert in your question department the following questions: (1) Give an explanation of the cause of the unbalanced condition of a two phase three wire circuit operating induction motors. (2) The diagram below shows the connections to a 12,000 volt, 3 phase, 60 cycle wattmeter G. E. type D-3. We have such a meter on one of our feeders, and in some way got the potential taps P-1 and P-2

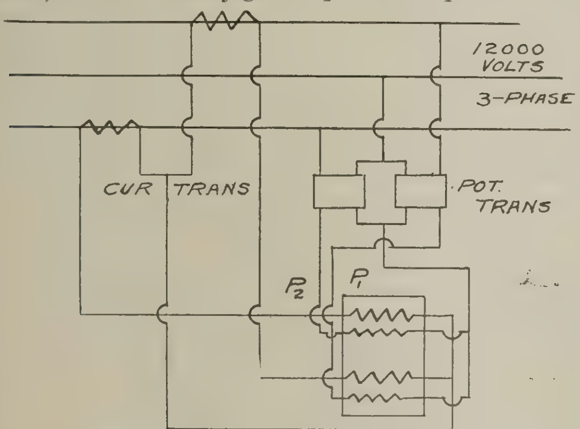


FIG. 1. WATT METER CONNECTIONS.

interchanged. The phases were practically balanced and the power factor was about 75 per cent. Instead of standing still, the meter registered in a positive direction over half of what it should have registered. Please give an explanation of this and give curves showing the phase displacement. R. W. SMITH.

VACUUM FOR TURBINE OPERATION.

Editor Southern Electrician:

(280) I have noticed question No. 272 in the February issue and would like to state somewhat similar circumstances and ask that some one explain in the next issue. We have a turbine plant of 5,000 kw. capacity which runs continuously, with a 28 inch vacuum. Would there be a loss or gain in operating cost for the plant to run at 26 or 27 inch vacuum and if so where can the loss or saving be expected to be found if there is such? W. A. T.

WIRING FOR INDUSTRIAL PLANT.

Editor Southern Electrician:

(281) Kindly request readers to give a general formula for determining the sizes of wire for industrial plant lighting and power circuits when the current to be demanded is known and also the distance to be transmitted is known. State for A. C. and D. C. systems. Give also in brief the requirements of the Underwriters that apply to the wiring from the entrance of wires to the building to the application of the current. R. S. B.

THAWING FROZEN WATER PIPES ELECTRICALLY.

Editor Southern Electrician:

(282) The writer has been advised that water pipes can be easily thawed out by properly connecting them in an electric circuit. Kindly advise the proper arrangements and furnish circuit diagrams. Can either alternating or direct current be used? W. H. H.

PROPER FIELD CONNECTIONS FOR GENERATORS.

Editor Southern Electrician:

(283) I would like information from your readers on the following trouble: About a year ago water got into the conduit carrying cables from two Ridgway generators under the floor and grounded the field line. Ever since the machines gain on voltage when the total load comes on.

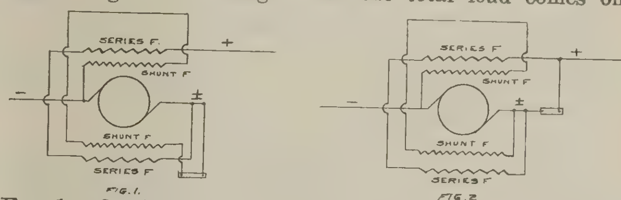


FIG. 1. ORIGINAL CONNECTIONS. FIG. 2. CHANGED CONNECTIONS.

There is a small shunt for connecting across the series coils of the machines. When I took charge of the plant the shunt was connected at one end to the positive lead and the other connected direct to one end of the shunt field of the machine. The connections are shown in Fig. 1. I have made the changes as shown in Fig. 2. The small shunt was placed across the series coils, the lead to it being taken from the positive terminal block. The machine still raises its voltage and sparks badly at the brushes. All the field resistance must be cut in to hold voltage down to 125 volts. When this is done there is no natural place for the brushes and the field distortion thus causes the sparking. I would like to know the cause of the trouble and how to remedy it. E. F. RICHMOND.

JUMPING BURNED OUT COIL IN D. C. MACHINE.

Editor Southern Electrician:

(284) Please give me, through the SOUTHERN ELECTRICIAN, directions for the quickest and best way of jumping a burned out coil in a D. C. series wound armature. WALTER ANDERSON.

How Transformer Core Losses Vary, Ans. Ques. No. 258.

Editor Southern Electrician:

In answer to question 258, I offer the following: The core losses of a transformer are made up of the hysteresis and eddy-current losses, of which the first is the larger. The hysteresis losses vary as the frequency, if the flux is constant, while the eddy current losses vary as the square of the frequency. In practice, however, the losses increase

as the frequency is lowered, since the flux density increases, and the iron losses vary about as the 1.6 power of the flux density. Therefore if a 133 cycle transformer is used on 60 cycles, or a 60 cycle transformer is used on 25 cycles, it will get too hot, although if the iron losses are quite low and the transformer is lightly loaded, it will frequently run without overheating. If the operating voltage is lowered about ten per cent the iron losses will be very little greater than before, but the capacity in K. W. will be lowered in about the same proportion.

Operation of Arc Lamps, Ans. Ques. 261.

Street arc lamps are usually equipped with some kind of a reflector but it is generally a small one of enameled steel used inside of the outer globe, although sometimes a larger outer reflector is used. One disadvantage of a large reflector is that it causes the lamps to sway in high winds. While there is no doubt but that the distribution might be somewhat improved by scientific reflector design, yet the arbitrary limitations as to spacing, such as street corners, etc., are such that there would be little if any decrease in the number of lamps needed. Furthermore variations in the light caused by wandering arcs, and similar causes affect the intensity of the light in various directions to such an extent as to render refinement in reflector design superflous.

As to the efficienices, the direct current lamp is more efficient than the A. C., as may be seen from what follows:

	Watts per m.s.c.p.	Watts per m.h.s.c.p.
D. C. Series..........	1,71	1.03
A. C. Series..........	2.95	1.83

The carbon life is about the same for both A. C. and D. C. lamps, being usually taken at 125 hours. Comparing the above lamps with the ordinary carbon filament incandescent at 3.1 watts per horizontal c. p. or 3.8 watts per m.s.c.p. we see that the arc lamp is about double the efficiency. The reason for this is simply that it is operated at a great deal higher temperature and hence gives off more of the short wave lengths which are the most effective for visual purposes.

Open Y Emergency Connection, Ans. Ques. No. 262.

This plan has been used, but only in case of emergency, as it is not considered good practice. The voltage between conductors and ground in this case would be $6{,}600 \div \sqrt{3}$ or 38,100 volts.

Size of Motor for Small Air Compressor, Ans. Ques. No. 266.

The work done in compression of air depends upon the amount of heat abstracted from it. If the air is not cooled during compression there is considerable heat liberated, and the pressure and work done is correspondingly greater. This is called adiabatic compression. On the other hand if all the heat liberated is taken away by a cooling jacket or other means so that the initial temperature is maintained, the compression is called isothermal. Neither of these is actually obtained in practice, but the compression curve usually is near to the adiabatic. For adiabatic compression the mean effective pressure is represented by the expression $3.463\ p_1\ [p_2 0.29/p_1) - 1]$ where p_1 and p_2 are the absolute initial and final pressures in pounds per square inch (absolute). In this case therefore, we have 15 pounds initial and 215 final. 215/15 gives a ratio of 14.3 which raised to the 0.29 power is 2.163. Subtracting 1 and multiplying by (3.463×14.7) we have 60 pounds M. E. P. The H. P. is then obtained by the well known formula, being the product of the M. E. P. x the area of the piston x the length of the stroke in feet x the strokes per minute $\div$ 33,000. This is the theoretical H. P. Adding 10 per cent to cover friction losses, we obtain nearly 1 H. P. for a single acting and 2 H. P. for a double acting compressor. If the compression could have been done isothermally the H. P. required would have been about two-thirds of this.

Qualifications for Illuminating Engineer, Ans. Ques. No. 267.

There are a number of requirements that could be given for the case cited, but they are all subject to more or less modification by local conditions which require some experience in the work to apply. The articles in SOUTHERN ELECTRICIAN by the writer on Illlumination have given a resume of these rules. If more detailed information is desired it can be obtained from the Engineering Department of the National Electric Lamp Association at Cleveland, Ohio, or from the Holophane Co. at Newark, Ohio, who will be glad to send bulletins, giving these rules.

The engineer should know the intensity of light required, the efficiency of the available sources, the effect of scientifically designed reflectors, the effect of interior finishings, and the proper height and spacing of the light units. For instance if it is desired to obtain three foot candles in a room of 200 square feet, we require 600 effective lumens. If we can get 5 lumens per watt, which is about a maximum for tungsten lamps and Holophane reflectors with light ceiling and walls, we would have to expend at least 120 watts in this room. The actual number and size of units can only be determined by a knowledge of the room conditions. One large unit might answer, but two or three smaller ones would likely give better results. The same process of calculation would have to be gone through for each room in the building.

Design of Solenoid, Ans. Ques. No. 268.

The nearest commercial size of brass tubing to fit this core would be 7/16 inch outside diameter and .347 inch inside. In this case the core had better be 11/32 inch as it would fit more snugly. The details of construction would depend upon whether or not the magnet were iron clad, or enclosed in a yoke. It would be better to do so if possible as the required pull would be obtained with much less current. Figs. 2, 3 and 4 show the construction. In any case the coil should be wound on a spool, which can be made easily by making a tube of fuller board or press board and glueing two fiber washers on the ends. One or two turns of .007 inch pressboard will answer for the tube. It should be as thin as consistent with strength. If an open solenoid is to be used the spool can be formed around it. If an iron clad magnet is used the best construction is to make a simple forging from a thin strip of bar iron. Then make a short iron plug to fit the inside of the brass tube, cut a shoulder on it and thread the end, also cut a slot in the large end for a screw driver, and pin it into the end of the

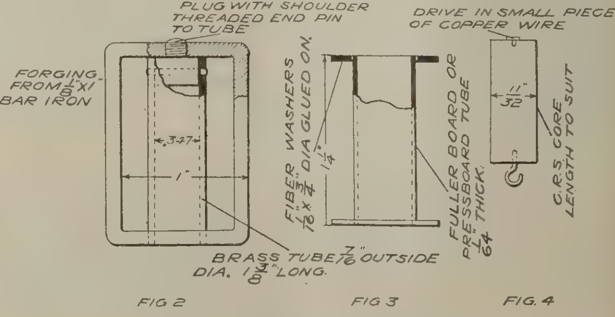


FIG 2 FIG 3 FIG. 4

FIG. 1. DESIGN OF SOLENOID.

tube. Then bore and tap a hole in the yoke, and by means of a screw driver the tube and upper core can be securely mounted in the yoke, after the coil is put in place. The core can be made any suitable length and should have a small hole drilled in the upper end and a short piece of copper wire driven in and flattened out to prevent "freezing" of the two together.

As to the winding, for 4 dry cells, I would use about 300 turns of No. 25 s. c. wire, requiring about 46 feet. This would have a resistance of 1½ ohm permitting 5 amps. and giving 1,500 ampere turns which should be ample. It is likely that 3 cells will operate satisfactorily, even on open solenoid, while if the iron clad magnet is used 2 cells should do the work. It is impossible to get fine enough wire in this space to stand 110 volts, but if No. 32 s. c. c. wire is used it may be used on 110 volt circuit with a 16 or 32 c. p. lamp in series, as may be found best by experiment.

A. G. RAKESTRAW.

Tests on Rotary Converter, Ans. Ques. No. 264.

Editor Southern Electrician:

I wish to submit the following in answer to question No. 264 of the January issue. The relation between Emf. at the two ends of a rotary converter is given by the following equation for an *n* ring converter. $En = (E_0 \sin 180^\circ/n)/\sqrt{2}$. For a three phase converter $E_3 = (E_0 \sin 60^\circ)/\sqrt{2} = E_0 \times 0.612$ or the A. C. voltage of a three phase machine = D. C. voltage $\times$ 0.612. Thus we see from the above equation that there is a definite relation between the D. C. voltage and the A. C. voltage.

When running the machine as an inverted rotary, any change in the field current will change the speed of the machine, but the terminal voltage will remain constant. The ratio of the converter = A. C. voltage ÷ D. C. voltage,

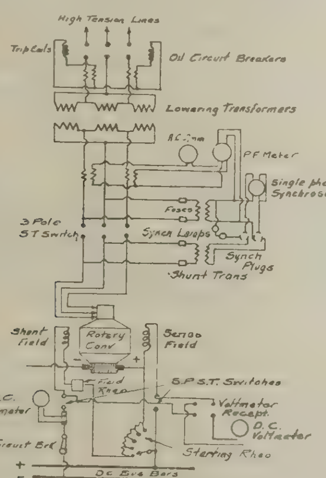


FIG. 1. DIAGRAM OF CONNECTIONS FOR 3-PHASE ROTARY CONVERTER STARTING FROM D. C. SIDE.

Due to the combined operation of a rotary converter, both as a motor and as a generator, the field distortion from the motor action is to some extent counteracted by that from the generator action, so that with proper field excitation the field strength remains approximately constant throughout a wide range of load. Hence the armature iron loss varies but slightly with the load, and may be considered to be independent of the load current. The variable loss then is due almost exclusively to the copper loss in the armature winding.

A rotary converter supplied with constant voltage alternating current tends always to produce a constant voltage on the direct current side. The terminal voltage decreases, however, as the load is increased, due to the resistance drop in the armature. This drop in the armature winding of a rotary converter is not as great as it would be if the machine is operated as a direct current generator. For a three phase converter the effective resistance for unity power factor is 58.5 per cent of the true armature resistance. Hence the I R or resistance drop is 58.5 per cent of the apparent drop in volts.

By measuring the no load losses and the armature resistance, the complete performance of the machine may be calculated as follows: R = Armature resistance; W = No loads watts input; R(eff) = Effective armature resistance; E = No load D. C. voltage; I = D. C. load current.

$R(\text{eff})$ for a 3 phase converter $= 0.585R$; then $I^2R(\text{eff})$ = copper loss in armature.

$E - IR$ = terminal D. C. voltage.

$W + EI$ = input.

The D. C and A. C. currents are approximately the same for a three phase rotary.

$EI - I^2R$ = Output.

$(EI - I^2R)/(W + EI)$ = efficiency.

The above equations are based on the assumption that the iron, friction and windage losses are constant. For running a test on the machine, connect converter as shown in the accompanying diagram. Keep the field current at best value for no load and vary the load on the D. C. side. Measure voltage, current and watts input; voltage and current output; speed and field current. The frequency and A. C. line voltage should be kept constant. Change in speed indicates change in frequency. From the data obtained the efficiency and voltage curves may be plotted. If results are desired in the form of a curve use cross section paper and plot current output as horizontal reference line with per cent efficiency and D. C. volts as vertical reference.

A. L. UTZ.

What is a Two to One Motor Drive? Ans. Ques. No. 269.

Editor Southern Electrician:

A 2 to 1 motor drive as used with a planer refers to an adjustable or variable speed type motor which by means of a regulating rheostat usually can be varied in speed from its normal rated speed through various steps up to a maximum speed of twice the normal rated speed. The speed of the ordinary standard shunt motor can be increased somewhat above normal, about 10 to 15 per cent, but trouble due to sparking at the brushes will result if the increase is much in excess of normal. Motor manufacturers have, therefore, designed motors that allow variations in speed above normal, up to ratios of 2 to 1, 3 to 1, 4 to 1 and even 5 to 1. For the latter variations special interpole motors are necessary or other special construction.

The speed of the motor can also be changed in various ratios by changing the voltage of the current delivered to the motor and also by means of inserting resistance (by means of a rheostat see figure 1) in the armature circuit of the motor. Speed variation by this latter method is not suitable for machine tool work, as change in load changes the speed. The former means (changing voltage) complicates connections, wiring, etc. In Fig. 1 it is to be noted that the resistance is inserted in series with the armature, thus varying the position of the rheostat handle changes the

amount of resistance in series and also the speed. Adjustable speed motors of proper design and with the correct controller for varying the current in the shunt field will give various numbers of selective speeds above normal and will maintain a constant speed at the various points without any trouble at the brushes. A variation of 2 to 1 is not uncommonly used.

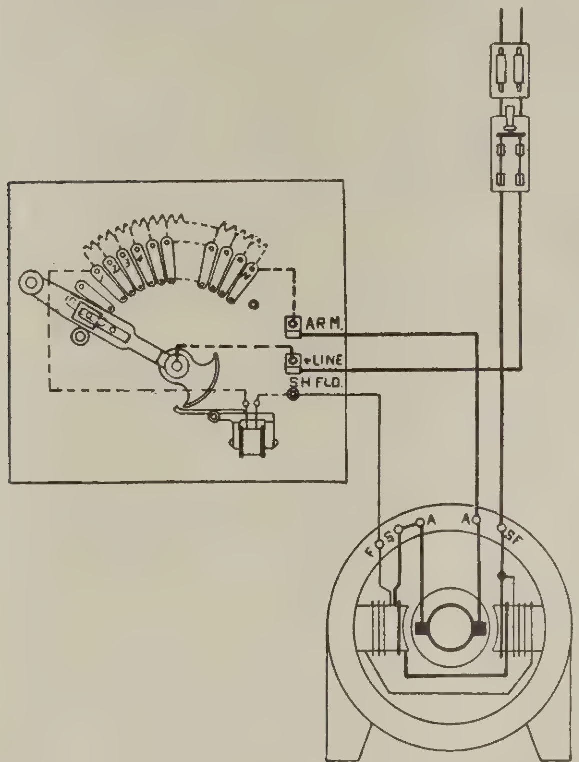


FIG. 1. VARIATION IN SPEED BY ARMATURE RESISTANCE.

When the speed of a motor is increased by inserting resistance in the shunt field circuit, the field strength is weakened because of the reduced current in the field winding and the armature revolves faster to generate the proper counter electromotive force. A motor of the proper adjustable speed type, as the 2 to 1 in question will regulate itself to maintain practically constant speeds at the various speed steps between its normal speed say of 800 and its maximum speed of 1,600 R. P. M. Another advantage of the field control of a motor such as is applied to such machine tools as lathes, planers, drill presses, slotters, shapers, boring mills, etc., and also printing presses,

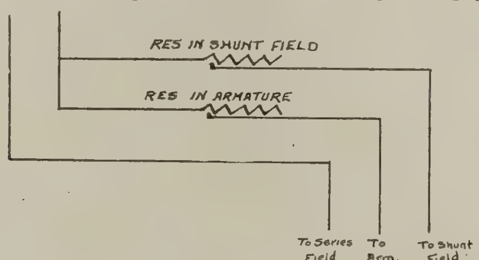


FIG. 2. VARIATION IN SPEED BY SHUNT FIELD RESISTANCE.

is the fact that all the current taken from the line is utilized for power. The changes in speed are obtained by inserting a small amount of resistance in the shunt field and not as in the armature resistance method of reducing speeds below normal, where considerable energy is dissipated in the resistance. The diagram Fig. 2 shows the connection for a motor with controller for varying the speed by shunt field control. Here the resistance is connected in circuit with the armature when starting. After normal speed is reached the handle is moved to give various steps of speed above the normal. Different rheostates cover different ranges.

The 2 to 1 motor for a planer should be preferably a compound-wound as the planer has periods of sudden and heavy power demands of short duration. The shunt wound motor is therefore not quite as well suited. Motors such as the Reliance, Stow, etc., change the speed by shifting the armature or the field poles. GEO. J. KIRCKGASSER.

Motor Connections, Ans. Ques. No. 224.

Editor Southern Electrician:

The same general wiring scheme applies in connecting either a shunt or a compound wound motor to a circuit. The only point of difference is that in the case of a compound wound machine it is necessary to make sure that the shunt and the series fields are of the proper polarity with relation to one another after the proper direction of rotation of the armature has been attained. Ordinarily the fields of a compound wound machine are connected in such a way that they assist one another, but in special cases the opposite effect is desired. That is, to weaken the fields of the machine as the load comes on. A simple method of checking the above connections is to connect the machine up first as a simple shunt motor, leaving out the series field entirely; then after proper direction of rotation has been attained disconnect the shunt field and connect up as a series motor and put sufficient current through the machine to ascertain which direction it tends to rotate as a series machine. This, under the usual system of connecting, should be in the same direction as when run as a shunt machine. If not, reverse the series field connections with respect to the armature and shunt field.

To further illustrate the method of connecting the above machines Fig. 1 shows wiring for a shunt machine, and Fig. 2 the same for a compound wound motor. It is immaterial which lead is positive or which negative in connecting up the machines, and has nothing to do with the operation thereof. It is likewise seldom necessary to know the polarity of the fields, as the coils are usually either already connected when the motor is received from the makers, or, if not, marked in such a manner that the proper connections may be readily effected. However, if it is desired to check the individual fields up, this can be easily done by means of a magnetic compass, or by a magnetized needle suspended by a cord attached to its center. Upon exciting the fields of the machine under test the positive poles will attract the south pole of the compass or needle,

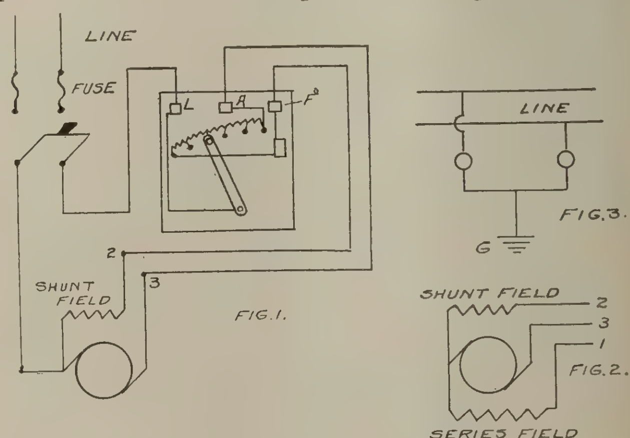


FIG. 1. MOTOR CONNECTIONS.

and vice versa. It may be remarked that consecutive poles round the machine should alternate in polarity when properly connected.

No fixed rule can be given for setting the brushes of a machine relative to the pole pieces, since this is dependent upon the method of connecting between the armature winding and the commutator, that is the throw of the leads. However, the brushes should be set at such a point that the armature conductors under commutation at a given instant are slightly back (as referred to the direction of rotation) of the mid-position between the two adjoining pole pieces. Similarly, the proper position for the brushes is that position which gives the least sparking at the commutator when running under normal load. A simple and inexpensive ground detector for low potential circuits may be constructed by connecting two incandescent lamps as in Fig. 3, in which case a ground on either side of the circuit will increase the brilliancy of the lamp connected to the opposite side and diminish the brilliancy of the other. The lamps used should be about of the same voltage as the system to which they are connected.

C. C. Hoke.

New Apparatus and Appliances.

Sherardized Outlet Boxes and Fittings.

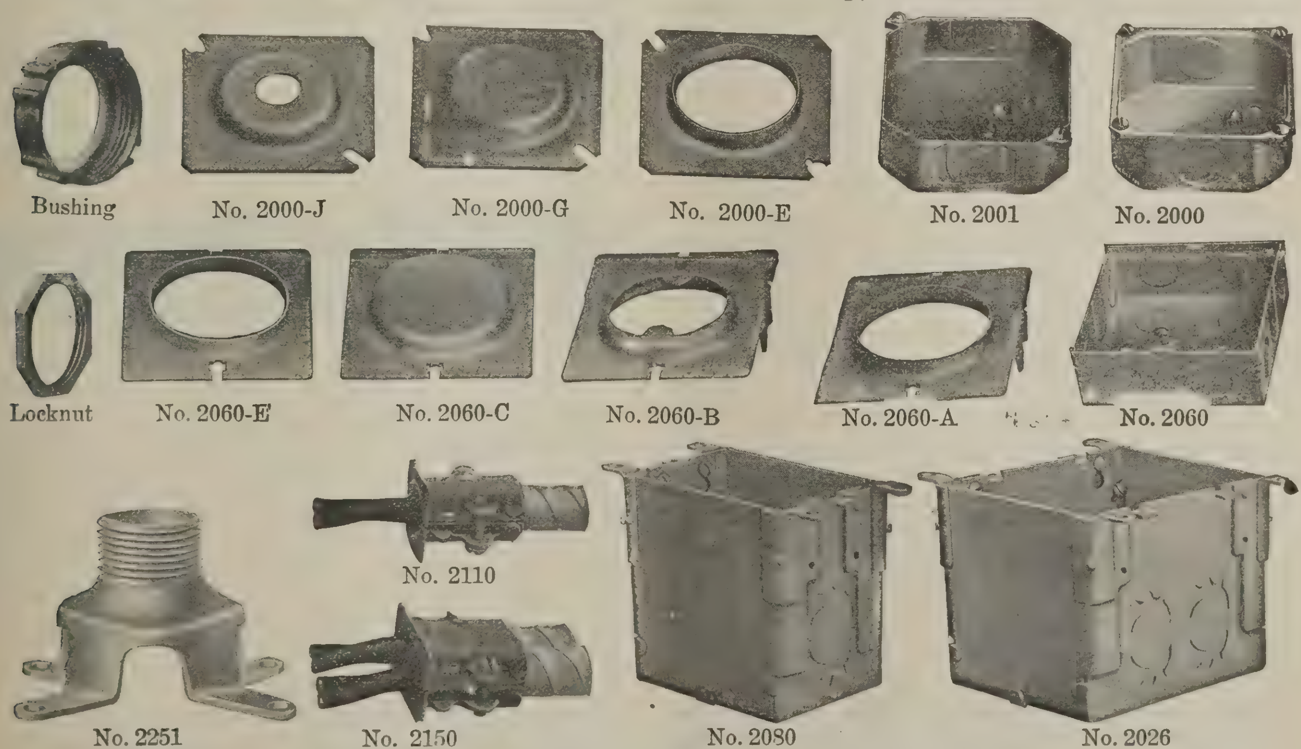
The National Metal Molding Company of Pittsburg, Pa., has placed on the market a new line of sherardized boxes, covers and fittings. The illustrations shown here represent the line in part, the full line being described and illustrated in Catalogue No. 1, where each part is given a number and also arranged for easy reference, is the number of the same type of fitting as manufactured by other companies. The complete line has a fitting for every purpose. All the boxes, covers and fittings are sherardized which insures against rust, gives a surface that readily takes paint, and assures an absolute bond between all fittings.

The National cable holders Nos. 2110 and 2150 are for use with flexible steel conduits and armored conductors, doing away with the handling of any locknuts or bushings. No. 2000 is a 3 inch rigid conduit box with 5 ½ inch knockouts, No. 2001 is the same box with one ½ inch conduit knockout in bottom and four special twistouts in sides to take special "no locknut" single and double cable holders No. 2100 and 2150. The covers shown are standard open cover No. 2000-E, closed cover No. 2000-G, closed cover with ⅜ inch bushing No. 2000-J.

No. 2060 is a standard 4 inch outlet box the special feature being that the covers are attached by one screw only, and knockouts are provided so that covers will fit all other standard makes of 4 inch boxes.

No. 2026 is a two gang switch box designed to take "no locknut" cable holders No. 2110 and 2150 and is a handy wall case especially recommended for old work. These boxes can be brought flush with the plaster line by the adjustment of four corner screws. No. 2080 shows a single wall switch box and No. 2082 is a spacer whereby any size box can be built up as desired. This box is for non-metallic flexible conduit. No. 2251 shows a ⅜-inch stamped hollow center fixture stud. An illustration of a National conduit bushing and "locknut" is also shown.

The main offices of the National Metal Molding Company are located in the Fulton Bldg., Pittsburg, Pa., and any further information on the above products can be secured from there or from the Southern office, at 4th National Bank Bldg., Atlanta, Ga.



New Line of Sherardized Outlet Boxes and Fittings of National Metal Molding Company.

A Combination Switch and Cutout.

The Chicago Fuse Manufacturing Co. have recently put on the market a line of combination switch and cartridge fuse cutouts ranging from 3 to 60 amperes in capacity for 250 volt circuits. These fittings are an extension of the Union line of porcelain cutouts, having the same general features of design. They are as compact as permissible by the Underwriters' specifications for switch spacings and have porcelain barriers between the metal parts of opposite polarity. With the recent ruling of the Underwriters against the use of the mica plug fuses on 250 volt circuts, there has been need for a compact unit serving as switch and cutout for motor work as well as entrance service cutouts. The old style slate base switch with fuse extensions, have much exposed metal. A porcelain combination switch and cutout, in which the parts of opposite polarity are protected from accidental short circuits, has an advantage therefore particularly in machine shops and other similar places.

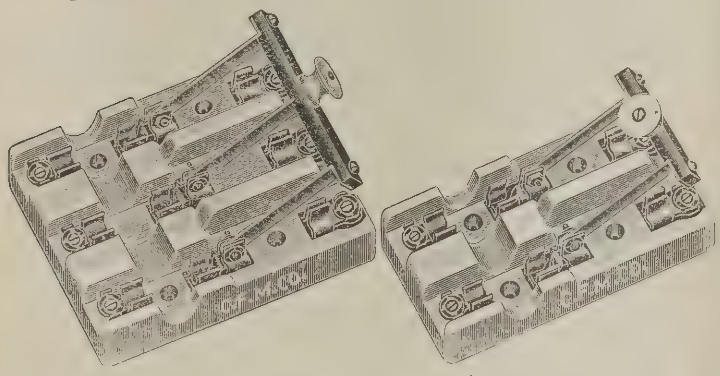


FIG. 1. DOUBLE POLE AND TRIPLE POLE BLOCKS.

The cuts herewith show the double pole and triple pole blocks, arranged for wires entering at the bottom when mounted in the upright position; the fuses protecting the device itself and the switch tending to fall down when not in use, thus complying with the suggestions of the Underwriters for the proper installation of knife switches. These switches are also furnished for wires entering at the top. The bases of these fittings are sufficiently thick to allow one inch spacing for knob and tube work and where used in basements or other damp places. The crossbars are of heavy fibre, having the knife blades mortised into them and securely attached by a screw. The clips are punch-formed and made of copper with liberal thickness to insure a lasting spring contact and cool operation under continuous load. The hinge contacts are formed in strict accordance with the Underwriters' specifications, the aim in design throughout having been to make a most rugged and serviceable switch and cutout.

New Westinghouse Tape.

The Westinghouse Electric and Manufacturing Company has recently placed on the market a bias cut, treated cloth tape which is made under a new process and for which some very satisfactory characteristics are claimed. It can be used as a continuous tape, having a good tensile strength through out its entire length, or may be divided into four foot lengths by tearing, or without the use of any cutting tool. Another advantageous feature is the absence of any sewed seams which when present, have to be cut to make a neat job. This tape also has the same dielectric strength throughout its length as the full width treated cloth. It also is free from uneven places due to the running of the insulating liquid which collects in the sewed seams during the process of treating. This new process tape has also been specially designed to have the very best possible amount of grip and slip; that is, it has a degree of tackiness that particularly adapts it for taping purposes.

Train Dispatching on the Piedmont and Northern Lines.

One of the great electric traction systems of the South, the Piedmont and Northern Lines, is about to enter the telephone train dispatching field, and with this end in view has placed orders with the Western Electric Company for equipment to be used on two of its lines. The first of these, the Piedmont Traction Company, is to operate its cars over a 24 mile stretch of line extending from Charlotte, North Carolina, to Gastonia, North Carolina. There will be seven way stations located along the line as well as eight semaphores of the new Western Electric selectively operated type.

The second line is that of the Greenville, Spartanburg and Anderson Railway, which will install telephone equipment over approximately 58 miles of road from Greenville, South Carolina, to Greenwood, South Carolina. Eleven way station equipments and eight semaphores will be installed. The equipment to be used is of the very latest type throughout, including the Western Electric No. 50-B selector and necessary telephone apparatus and accessories. The selectively operated semaphore is a new development and is operated by the dispatcher by means of a selector key in the same manner that a way station is signalled. An "answer back" or audible signal informs the dispatcher when the semaphore has operated.

Minerallac Unity Insulator.

A combined insulator and pin, of one piece of wood, thoroughly impregnated with a compound which it is said gives the highest insulating qualities, and is a remarkable preservative, has been placed on the market by the Minerallac Electric Company, of Chicago, Illinois. This combined insulator and pin is tured out of a solid piece of wood of the kind best adapted to the purpose; then its insulating properties are added and the life of the wood prolonged b ya thorough impregnation with Minerallac

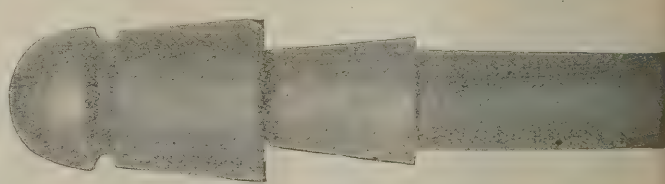


FIG. 1. MINERALLAC UNITY INSULATOR.

compound, which is an unexcelled wood preserver. Its effest in increasing the insulation is remarkable. Insulators made of materials similar to those in the Unity insulator are said to have been steadily in service without breakdown or jump-over on 4,000, 9,000 and 12,000 volt high-tension lines, on a large central station company's plant. Some of the earliest installations have been in actual service as much as 8 years and show no deterioration in insulating qualities, nor any tendency to crack or split.

As far as mechanical strength goes, experience has already shown that it will stand up without breakage under conditions more severe than the heaviest line construction.

There is no joint or groove between the insulator and supporting sections, all the natural toughness of the wood being available to resist mechanical line stresses. It resists the small boy with a gun or slingshot.

A Non-Metallic Flexible Woven Conduit.

BY W. N. GODDARD.

The Tubular Woven Fabric Co. of Pawtucket, R. I., have recently put on the market a non-metallic flexible woven conduit called Duraduct. The principle embodied in the construction is said to be entirely new, the wall of the tubular fabric being built up of an outer surface of woven cotton, an intermediate layer of hard twisted insulating paper and a woven cotton interior surface. These three layers are interwoven forming a single wall structure that is inseparable, non-collapsible and indestructible. It is claimed that kinking, looping, flattening or twisting the fabric even in cold temperatures does not effect the interior for when straightened the inside diameter remains the same with absolutely no blisters or obstructions for the wire.

The weave is such as to possess extreme flexibility together with great tensile strength and non-abrasion qualities and is peculiarly adapted for holding the compounds making it both flame and moisture proof. The interior surface is of unique design, in being a rounded point surface which allows the wires to slide over with much less friction than over a flat or line surface. Duraduct is manufactured, inspected and labeled under the supervision of the Underwriters Laboratories, Inc.

Lifting Magnets for Handling Steel Pipe.

Lifting magnets are not only adapted for use in the large steel mills and other plants where large quantities of pig iron, etc., is handled, although this is more or less the common belief. Many efficient and money-saving applications of lifting magnets are in plants where their installation would hardly be thought successful. An interesting installation of this kind has recently been made in the plant of the Rockwood Sprinkler Co., Chicago. The magnets shown in the illustrations are of Cutler-Hammer special 18-inch design. This factory turns out assembled parts for sprinkler systems, consisting principally of steel piping, ½-inch to 10-inch sizes, fittings, valves of various kinds and sizes, sprinkler heads, etc. The magnets are used for carrying the steel pipe from the flat cars, the extension of the trolley track overhanging the railroad spur. The storage house has compartments for the various pipe sizes and the magnets deposit the load in the proper place. For this work only one man is required and the pipe can be unloaded and sorted in the quickest time. Loading the cars with complete equipments can also be easily accomplished. As the crane and magnets work overhead, no floor space is wastetd for trucking. A motor-generator set furnishes the 220-volt direct current for the magnets, the current consumption being only 1.9 amperes per magnet, less than the consumption of a household electric iron.

The Renewed Lamp.

The renewal of burned out incandescent lamps has been attracting the attention of all consumers of carbon lamps for the last twelve years, and the progress made in this line has been very noticeable. Before the renewal principle was made practicable all consumers of incandescent lamps would throw away the burned out lamp, thinking it was of no value. But since it has been made manifest that the bulb can be utilized again by the insertion of a new filament, consumers who have looked into the matter of cost saving have become assured that the renewal of a carbon in a burned-out lamp is in every way practicable, and can reduce the cost from thirty to forty per cent. in lamp maintenance.

The process of the insertion of a new filament in the renewed lamp, with the apparatus for exhaustion and testing methods, is the same as used in the manufacture of the new lamp. The standard filament is used, and the same process of manufacture is used, the only difference being that the manufacturers of renewed lamps do not assemble and make the bulbs. The Re-New Lamp Co., of Malden, Mass., which has established its name throughout the country and is said to be the largest manufacturers of renewed incandescent lamps, states that when consumers understand the situation, irrespective of prejudice, they cannot see why the properly constructed renewed lamp is not as perfect as a new lamp, and in consequence there has been a material increase in the resuscitation and rebuilding of incandescent lamps. These statements may be new to some consumers of incandescent lamps and those who may read this article will not lose by investigation. Wilson S. Howell, manager of the New York Electrical Testing Laboratories, states that his experience for three consecutive years has proven to him that a well constructed renewed lamp is equal to the new lamp.

Battery Charging and Transfer Switch Panel.

Duplicate batteries are often used on circuits for electric clocks, railway signals, electric bells or gongs in schools and manufacturing plants. The batteries are alternated, when one set becomes discharged, they are transferred to the charging side while the charged battery is cut in on the working circuit. A panel has recently been placed on the market by the Cutler-Hammer Manufacturing Company, of Milwaukee, and provides for transferring the batteries used for the above purposes without an instant interruption of the working circuit, putting the battery on charge and the other on the working circuit. Charging line connections can be made to any 110 volt D. C. circuit and the charging side while the charged battery is cut in on the working circuit. A panel has recently been the charge when the desired maximum voltage is reached. One fuse of each the charging and the working circuit has additional terminals on front of the panel, making it convenient for cutting in an ammeter on either circuit without interrupting the circuit. Automatic means for transferring the batteries when one set is discharged can also be provided with this panel.

Attachment for Pull Socket.

The Economy Electrical Specialty Co., of Charlestown, Mass., announce that a recent change has been made in their attachment for pull sockets making its application universal. That is the device can be used on, Hubbell, Paiste and Arrow E new interior pull sockets. The above pull socket was described and illustrated on page 241 of the December issue of Southern Electrician.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

ALEXANDER CITY. The Birmingham, Montgomery and Gulf Power Co. plans the development of a water power on the Tallapoosa River at Cherokee Bluff, near Alexander City. It is understood that the cost of this plant will be three million dollars. Charles H. Baker, of New York, is promoting the enterprise and it is understood that it will be of sufficient capacity to develop 30,000 horsepower.

BIRMINGHAM. The Birmingham Metal Products Co. has been organized with a capital stock of $35,000 by Solon Jacobs, J. H. Dean and others. The company plans to manufacture a patented corrugated iron.

BIRMINGHAM. According to reports from T. H. Friel, president of the Birmingham Light & Power Co., it is learned that the company will begin in a short time the development of water power at Lock 16 on the Warrior River. The electrical energy generated at this point will be transmitted to Birmingham.

BIRMINGHAM. It has recently been announced that 20 miles of track will be constructed between Milstead and Eclectic, Ala., by the Birmingham and Southeastern Railroad. W. M. Blount is president and is located at Montgomery, Ala.

GADSDEN. The Gadsden Car Works will install an electric light plant and make other improvements to their equipment, the cost of same being about $20,000.

HUNTSVILLE. A new pumping station is to be erected by the water commissioners.

MOBILE. The Southern Electric Co. has been incorporated with a capital stock of $3,000 by J. A. Hollifield, D. A. Alexander and A. J. Spencer.

MONTGOMERY. The Central Alabama Power Co. has been organized with Henry Horne, of Macon, Ga., as president. It is understood that this company plans the construction of a number of power plants.

VINEGAR BEND. The Vinegar Bend Chemical Co. desires an electrical generating plant equipment sufficient to operate about 300 lights. D. H. Green is general manager.

FLORIDA.

MIAMI. The Miami Electric Light & Power Co. is planning to build an addition to its electric plant.

ZEPHYR HILLS. It is understood that plans are being considered for the installation of a new electric light plant. Francisco & Sons are interested.

GEORGIA.

AMERICUS. The Americus Gas & Electric Co. has issued bonds to the extent of $300,000 and stocks to the extent of $250,000 for the purpose of making extensions and improvements to their plant.

ATLANTA. The Merchants Electric Co. has been organized for the purpose of furnishing current to a number of centrally located department stores. It is understood that a plant of 200 K. W. capacity will be installed.

CARROLLTON. It is understood that S. D. Brown, of Carrollton, desires prices on a 250 K. W., three-phase, 60-cycle, 220-volt, second-hand direct-connected generating unit.

DALTON. Prices are being secured for the installation of another unit in the municipal electric light plant, and negotiations are under way with the Eastern Tennessee Power Co., of Clarksville, Tenn., and the North Georgia Electric Co., of Gainesville, Ga., to deliver energy at the city's switchboard for street and commercial lighting. D. C. McCamy is general superintendent.

GAINESVILLE. A charter has been granted to the Gainesville and Northeastern Railroad Co., with a capital stock of $750,000. The company plans to construct a railway between Gainesville and Robertson, Ga., by way of Cleveland, a distance of 35 miles. H. H. Dean, M. C. Brown, J. E. Redwine, of Gainesville, are the incorporators.

HELENA. Plans have been prepared by J. B. McCrary & Co., for an electric light plant.

KARNESVILLE. The Frankford Light & Power Co., chartered with $150,000 capital stock, plans the development of water powers on the Broad and other rivers in Franklin and Hart counties, and transmitting electricity to Karnesville, Canton and Royston in Franklin county and Barsville in Hart county. The incorporators are W. W. Lotspeich, M. H. Terrell and U. S. Seal of Atlanta.

LAGRANGE. It is understood that the Chamber of Commerce of Lagrange is considering plans for the construction of an electric railway between West Point and Lanett, Ala., southwest to Lagrange and to Hogansville and Newnan to the Northeast.

MACON. The Georgia Railway & Power Co., has opened offices at Macon, and will compete with the Central Georgia Power Co., for power customers in and around Macon.

MACON. Mr. W. H. Fetner, Chairman of the Board of Water Commissioners of Macon, has requested bids for induction motors and centrifugal pumps to be installed in the municipal plant at Macon.

MEIGS. An election was held February 27th to vote on the issuing of $5,000 in bonds for an electric light plant.

McDONOUGH. A franchise has been granted to J. G. Smith to operate an electric light plant. A water power plant will probably develop the energy.

SWAINSBORO. The city council called an election on February 12th to vote on the issue of $7,000 in bonds for the purchase of an electric light plant. The local electric light plant owned by Jesse Thompson was closed January 1st, and since that time the city has been without street lighting service.

VALDOSTA. Bids are being received for contracts to construct a line westward from Moultrie, Ga., for the Valdosta, Fort Gaines and Western Railroad Company. Mr. Frank Roberts is president, located at Valdosta.

KENTUCKY.

ASHLAND. The Ashland Leather Co., has given a contract for the erection of buildings to the Moore Construction Co., of Charlestown, W. Va. The building includes a two story boiler house and a one story engine room. The mechanical equipment will be electrically operated and a 150 H. P. engine and 100 K. W. generator will be installed.

BEREA. The erection of a water plant is being planned by G. P. Holliday and others.

CATLETTSBURG. The Big Sandy Electric Co., has been granted a charter with a capital stock of $5,000. The incorporators are G. W. Poling, F. S. Fisher, and S. B. Warnock.

LEXINGTON. A tract for the erection of a sub-station to the Capitol Lumber & Mfg. Co., has been awarded by the Kentucky Traction and Terminal Co. The equipment will include two 300 K. W. units.

LOUISVILLE. The Louisville and Interurban Railway Co., has purchased a site for a power house. Plans for the structure have been prepared by D. H. Murphy & Co., of Louisville. S. H. Miller, Superintendent of motive power of the company, is in charge of the engineering detail. It is understood that the equipment will consist of two steam turbine units with approximately 5000 K. W. normal rating installed with the necessary boilers and auxiliaries, together with two 2000 K. W. rotary converters for the trolley system.

LOUISVILLE. The Kentucky Public Service Co., has been incorporated with a capital stock of $380,000 and taken over the plant and holdings of the Capitol Gas & Electric Co., of Frankfort, Ky., the City Light Co., of Hopkinsville, Ky., The Bowling Green Gas Light Co., of Bowling Green, Ky., and the Owensboro Gas Light Co., of Owensboro. R. T. Lindsley, H. Fitch and F. Austin, of Louisville, are the incorporators.

MIDWAY. The Midway Electric & Supply Co., has been organized and will erect an ice factory in the immediate future.

MIDDLETOWN. A commercial club has been organized to promote the establishment of a light plant and ice factory and similar establishments in this territory. Henry Frank is president and T. G. James the secretary of the organization.

NORTH CAROLINA.

ANDREWS. It is understood that the city is contemplating the installation of a hydro-electric plant to supply electricity for light and power about the city. Further information can be obtained from J. Q. Barker.

CHARLOTTE. The Charlotte Electric Railway, Light & Power Co., is planning the building of an extension to the Mecklenburg Country Club.

DILLSBORO. The Dillsboro & Silvia Electric Light Co., is planning the installation of a 50 K. W. generator and water wheel on the Tuckaseigee in Dillsboro.

DURHAM. A company is under way for the distribution of electrical energy taken from the transmission lines of the Southern Power Co., at Charlotte. G. L. Lyon is interested.

ELIZABETH CITY. Fire recently destroyed the electric plant of Elizabeth City Electric Light Co.

GASTONIA. It is understood that the city contemplates the issue of $5,000 in bonds for improvements in the electric light plant.

KENILWORTH. It is stated that the Kenilworth Development Co., proposes to erect an electric light plant in connection with the club colony which it intends to establish. J. M. Chiles of Asheville is interested.

KERNERSVILLE. The cty council will submit the proposition of issuing $5,000 in bonds for the construction of an electric light plant to a vote.

LEWISBURG. Plans are underway for the rebuilding of the pole line in connection with the municipal electric light plant. Robert C. Beck is Superintendent and can give other information.

ROCKY MOUNT. The Rocky Mount Machine Works has been incorporated with $50,000 capital stock by L. H. Pearsall, S. F. Jenkins and T. P. Jenkins.

ST. PAUL. The St. Paul Light & Power Co., will open bids March 1st for the erection of an electric light plant and grist mill to replace the structures which have recently been burned. A 60 K. W. generator is desired.

TURNERSVILLE. The city will vote some time in March on a bond issue for the installation of an electric light plant. W. T. Stafford, the mayor, can give other information.

OKLAHOMA.

CANADIAN. The Oklahoma Modern Electric Supply Co., has been incorporated with a capital stock of $25,000 by F. G. Gillock, W. E. Crowder, E. C. Brice, W. R. Alexander and H. N. Ames.

EL RENO. The El Reno Gas & Electric Co., contemplates extending its transmission lines to Darlington, Fort Reno, Yukon. H. H. Stephens is the manager and can give other information.

ELK CITY. It is understood that the local electric light plant has been purchased by Dr. Brenham and W. H. Goodyou of Hobart. It is further stated that $10,000 will be expended for improvements and extensions to the system.

MULDROW. An issue of bonds to the extent of $33,000 has been voted for the construction of a water works and the erection of a transmission line from Fort Smith, Ark., to Muldrow, to furnish electricity for operating the pumping station and for street lighting. It is stated that contracts have been awarded to F. R. Stone of Lima, Ohio, and the Western Engineering Co., of Oklahoma City, Okla., is acting as consulting engineers.

MUSKOGEE. It is understood that the Pioneer Telephone and Telegraph Co., is planning to provide 2500 additional telephones and placing underground about 10,000 feet of lead cable. The improvement will cost about $25,000.

MUSKOGEE. The Park Hill Improvement Co., 622 Equity Bldg., desires prices on generators and electric lighting equipment.

WAGONER. A bond issue has been voted for the construction of a municipal electric light plant. The plans call for one 150 kva and one 200 kva generator connected to Corliss engines. R. R. Harrison is commissioner.

SOUTH CAROLINA.

CAMDEN. The city will vote during April on the 100,000 dollar bond issue for an electric light plant and water works system.

JOHNSTON. The Electric Light & Fuel Co. is installing a ten ton ice machine in its electric plant. S. M. Boyd is president and manager.

LOCKHART. The Lockhart Power Co., with capital stock of $100,000 has been organized by W. S. Montgomery and Alfred Moore.

UNION. The erection of a transmission line to the city pumping station will be begun soon. R. A. Esterline is manager of the municipal electric light plant and water system.

YORKVILLE. The city has voted on a bond issue for the extension of the electric light system.

TENNESSEE.

CHATTANOOGA. A franchise has been granted to the Chattanooga, Rome and Atlanta Railway Co., which proposes to build and operate an electric railway from Chattanooga Southward into Georgia.

HENDERSON. The Priestly-Lord Light & Power Co., has awarded a contract to Fairbanks-Morse & Co., of Louisville, Ky., for furnishing electrical equipment for its power plant, consisting of an 80 H. P. oil engine, one 55 K. W. direct current generator, and switchboard.

HUMBOLDT. The Gibson County Telephone Co. has increased its capital stock from $5,000 to $10,000.

MEMPHIS. It is understood that plans have been completed for the installation of a white way system on Madison Ave. Under the plan now formulated, the cost of installing lamp standards is to be paid by the property owners and the expense of maintaining the lamps will be paid by the city. 80 lamps will be installed and the cost of electricity per lamp will be $54.00 per year each.

PULASKI. It is understood that plans are being prepared for the rebuilding of the municipal electric light plant for which in July bonds were issued to the extent of $20,000. It is further understood that the work includes the installation of a 125 H. P. and a 150 H. P. medium speed automatic engine, one 75 K. W. and one 100 K. W. three-phase 2300 volt generator. When the plant is rebuilt, 24 hour service will be established. C. L. Wheeler is engineer.

SHELBYVILLE. The Duck River Power Co., has increased its capital stock from $35,000 to $100,000.

SPARTA. The A. & T. Power Co. is planning the erection of a transmission line from Cookeville to Sparta, Tenn. It is understood that the company desires to communicate with hydraulic and electrical engineers to discuss this work. J. R. Tubb is president.

TEXAS.

BEAUMONT. The Beaumont Light & Power Co. has perfected plans for the installation of an ornamental street lighting system on Pearl Street. The company agrees to install the system provided the property owners enter into a contract with the company for a period of five years to maintain the lamps. The company further agrees to furnish arc lamps at $60.00 each per year, which is twelve dollars less than the rate which the city pays under the present contract.

CACHUCA. The Cachuca Light, Power & Railway Co. is planning to construct an irrigation system that will afford a water supply for more than 50,000 acres of land in the territory around Tula. The company has plans for the construction of a dam that will form a reservoir of large capacity and the building of a main dam about 62 miles long.

DALLAS. The Loab Dye Works desires prices on electric motors. Phillip Weaver is manager.

EDNA. Mr. E. F. Glaze has purchased the electric plant at this place and will make improvements.

FREDERICKSBURG. The electric light and power plant at Fredericksburg is to be improved by installing two new generators. A new 125 H. P. engine has recently been put in.

GALVESTON. I. A. Walker desires prices on an 8 to 10 K. W. direct connected 110 volt electric generating equipment operated by a gasoline motor. Prices are also desired on indirect lighting fixtures.

SAN ANGELO. The San Angelo Power & Street Railway Co. is the name of the reorganized corporation which is to take over the street railway system at San Angelo operated under the ownership of J. D. Sugg. It is announced that a new power house will be erected and new considerable equipment purchased.

TOYAH. The Toyah Light & Ice Co. has entered into a contract with the city council for the lighting of the town. A number of street lights will be installed and improvements will also be made to the company's plant.

WICHITA FALLS. The Citizens' Light & Power Co. has been formed here with a capital stock of $21,000. The incorporators are T. E. Dobson, I. W. Gullahorn, and Sam Levi.

MEXICO.

GUANAJUATO. The Guanajuato Power & Electric Co. has completed arrangements for the construction of a 50 miles extension to its electric power transmission line from Guanajuato to Tozox for the purpose of supplying the mines of the Auguxtiax Mining Co. with power. This is the third power on the Angelo River to be constructed and will double the generating capacity of the company.

TAMPICO. The two electric light plants and street railway lines have been merged into one ownership. It is reported that a new power plant will be installed and of considerable improvements will be made to the street car lines extending to La Barra, and to a number of other nearby towns.

BOOK REVIEWS.

POWER PLANT TESTING, by James Ambrose Moyer. Published by McGraw-Hill Book Company, New York City. 422 pages, 271 illustrations. Price $4.00.

The author of this work has successfully set forth in a convenient and ready form for reference, the essential features required for experimental work and the testing of prime movers and mechanical devices in a power plant. It is a most essential work for those who desire an authorative source of information on this subject and a feature which makes it most commendable for general use is the presentation of all tests in such a manner that the practical man in either the large or small plant will find its contents suited to his requirements as a reference text. While no particular directions are given for tests the general instructions are such that the reader can readily determine what he must obtain in the way of data and most successful method of securing and arranging it, by carefully going over the subject matter treating the test at hand. We recommend the work most highly as a practical and authoritative text on testing. The contents follow:

(1) Measurement of Pressure; (2) Measurement of Temperature; (3) Determination of moisture in steam; (4) measurement of areas; (5) Engine indicators and reducing motions: (6) Measurement of Power; (7) Measurement of flow of fluids; (8) Calorific value of fuels; (9) Flue gas analysis; (10) Boiler testing; (11) Steam engine testing; (12) Testing of steam turbines and turbine generators; (13) Methods of correcting steam engine and steam turbine tests to standard conditions; (14) Gas engine and producer tests; (15) Tests of ventilating fans or blowers and air compressors; (16) Tests of refrigerating machines; (17) Tests of hot air engines; (18) Tests of hoists, belts, rope drives, and friction wheels; (19) Tests of hydraulic machinery; (20 Tests of strength of materials.

STEAM-ELECTRIC POWER PLANTS, by Frank Koester. Published by D. Van Nostrand Company, New York. Second edition, 447 pages. 500 illustrations. Price $5.00.

This work is a practical treatise on the design of central light and power stations dealing particularly with economical construction and operation. The author is a consulting engineer of wide experience and this work is a companion to another by him on Hydro-electric Developments and Engineering. Both subjects are ably treated and cover in a most thorough manner features of good design as presented in most modern plants in this country and abroad. The contents of the book is divided into eleven chapters, the topics discussed speak the nature of the work. (1) Practical problems, efficiency and cost of plants; (2) location, general layout, coal storage and condenser water supply; (3) foundations, buildings, structural steel and architectural features; (4) boilers, stokers, chimneys, feed water heaters, superheaters, etc.; (5) piping; (6) prime movers, engines, turbines, pumping machinery, etc.; (7) electrical equipment; (8) design of small plants; (9) testing power plants; (10) descriptions of American and European light and power plants; (11) data and illustrations of recently constructed light and power plants.

TELEPHONY, by Samuel G. McMeen and Kempster B. Miller. Published by American School of Correspondence, Chicago. 948 pages. Price $4.00.

When two as prominent electrical engineers in the telephone field as the above authors together produce a work of the size and nature of Telephony, it is natural to expect that the features of the art will set forth in a manner that will enable the reader to secure for study or reference the essentials in as far as they are judged such by these two men who have searched to the very depths of both theory and practice.

In Telephony the reader will not be disappointed in the above expectation, whether he be a technical telephone man or a practical one for the work is a most comprehensive and detailed exposition of the theory and practice of the telephone art. The fundamental principles, sub-station equipment, party line systems, protection, switchboards, automatic systems, intercommunicating systems, power plants, construction, train dispatching, etc., have all as well as other subjects been treated thoroughly, clearly and simply. Every telephone man should own a copy of the work.

DATA. Devoted to engineering data. Published by Edward Wray, 106 N. La Salle St., Chicago, Ill. Price $2.00 per year.

There has been published fifteen issues of the above publication including in all over 400 sheets of valuable engineering information arranged in a most intelligent manner on sheets 3 by 5 inches, enabling a card system of filing for reference. This work has been widely recognized and is fulfilling a most essential service to all engineers whatever may be their particular line of work. In volume I of Data, about 300 sheets were presented of which 46 were on data refering to the engineering of buildings, 33 were on electrical subjects; 17 hydro-electric information; 16 were on illumination; 91 on power plant subjects, covering building costs, equipment costs and features of designs; 42 were on railway subjects and 23 on telephone matters. Covering this wide range in a manner as it does, the work is one which no engineer can be without and hope to possess recent and definite details on engineering subjects.

PROCEEDINGS OF AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION. Published by American Electric Railway Association, New York City.

The above association has bound into one volume the reports of the various committees of the Engineering Association presented at the ninth annual convention held at Atlantic City, New Jersey, Oct. 9 to 13, 1911. The volume contains 974 pages and presents the reports of the following committees: On standards; on way matters; on engineering accounting; on power generation; on equipment; on power distribution; on buildings and structures; on heavy electric traction; on block signals for electric railways; on engineering apprentices; on rules of procedure of committee on standards; on question box.

EIGHTH YEAR TOPICAL INDEX OF THE ELECTRIC JOURNAL. Publication office, Murdock-Kerr Bldg., Pittsburg, Pennsylvania.

The Electrical Journal mailed with its January issue the 8th Year Topical Index. The value of this index to those who are regular readers of the journal is already recognized for it is a most complete index to the valuable material which has appeared in the above publication during the period of eight years. It now covers some 6,500 pages of technical matter covering a wide range of articles of engineering interest. Through the careful arrangement of this index, it is an easy matter to locate any particular subject, since all articles have been classified under four divisions, namely, generation, transformation, transmission, and utilization of electrical energy. The index is in the form of a 48 page publication, and may be secured in bound form, or the individual items mounted on cards as the basis of a card file. Those who have not secured copies may get further information from the publication office.

STEAM TABLES FOR CONDENSER WORK. Issued by Wheeler Condenser & Engineering Company, Carteret, N. J.

This book is compiled in such a way as to be of practical service to engineers having to do with engine, turbine and condenser work. It contains three steam tables of interest. (1) Vacuum referred to a 30-inch barometer as the independent variable. (2) Temperature as the independent variable. (3) Properties of steam above atmospheric pressure with gage pressure as independent variable. These tables have never, to our knowledge, been published in the form presented. In the remainder of the hand-book the subject of vacuum measurements and the correction of vacuum gage and barometer readings is discussed. The book will be sent upon request to mechanical engineers making such on their own or their company's letter head.

PERSONALS.

MR. P. C. GILLAM has recently been appointed manager of a retail electrical store operated by the Western Electric Company from the Lee Street branch at Atlanta, but located in the business section of the city. Mr. Gillam's appointment has come in recognition of his thorough knowledge of the retail and electrical contracting business and from his extensive acquaintance in and around Atlanta. He will be assisted by W. M. Gregory, formerly of the Electrical Construction Company of Atlanta.

MR. CLARENCE E. CLEWELL, who for the last two years has been in charge of the design and installation of the extensive lighting work at East Pittsburgh shops of the Westinghouse Electric & Manufacturing Company, has recently been transferred to the sales department of the Electric Company and is now engaged in illuminating engineering work in connection with Detail and Supply Department.

MR. GEO. H. McCORMACK has resigned his position as sales manager and treasurer of the Opalux Company, taking effect Feb. 10, 1912, and will shortly announce his new connection.

MR. F. F. FOWLE, who has established for himself an enviable reputation as a consulting engineer and investigator has announced that he will close his business in Chicago and become associated with the McGraw Publishing Company, at New York City, as Assiciate Editor on the staff and of the Electrical World. He expects to make the change about the middle of February. Although Mr. Fowle has been very busy in his profession he has found time to contribute liberally

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CONTENTS.

New Business Methods and Results.

We sincerely hope that every reader of SOUTHERN ELECTRICIAN interested in the central station field and that of the electrical dealer and contractor will read carefully the material appearing under the heading, "New Business Methods and Results," found elsewhere in this issue. This title heads a new and permanent development in SOUTHERN ELECTRICIAN which has received our careful and thoughtful consideration for months past. While the interests of the parties above mentioned have always received attention through our reading pages, no particular section has, previous to this date, been set aside for the discussion of their commercial problems.

In starting a new line of activity in and through any publication, it is most essential that the purpose be definitely set forth. In this case the main goal is evident from the title of the department, namely, the promotion of successful progressive new business methods from the standpoints of central stations, electrical dealers and electrical contractors. The means to this end must necessarily be varied and the logical outgrowth of carefully formulated plans modified as practical requirements demand. In each issue until further notification, there will appear a complete presentation of a particular phase of the new business problem, together with the practical features as they have presented themselves under a particular set of circumstances. In the presentation of any of this material we earnestly solicit the co-operation of all interested, your criticism and suggestions and the nature of your particular problems. We strongly urge those central stations, electrical dealers and contractors contemplating the establishment of a new business department or any activity tending toward such a department, those who already have such departments and those who are otherwise in any way interested, to use SOUTHERN ELECTRICIAN as a clearing house for information. All requests for information or data on campaigns of any character will be given preference over other material to appear in the section and each and every problem will be given individual treatment as far as it is possible to do so. Now is the time to make suggestions, send them, many or few, and they will be worked out as fast as possible through the new business section.

These plans have been explained to a few of those closely in touch with the general situation and vital suggestions have been received. We thank our friends for this consideration and always welcome it. A few of the expressions set forth give viewpoints from the different angles. The following is from a party interested from all standpoints in the work for the sake of the good it is possible to do, no financial interest in any field prompts the expression:

"The new department which you intend to install in the SOUTHERN ELECTRICIAN is one that I have felt for sometime was needed in your paper, and one which will not only be a circulation builder for you, but will be appreciated by the industry as a whole. Perhaps the industry hasn't advanced quite to the point where we can say that we

can go no further with the physical development, but it is true that the industry has grown faster with reference to its physical equipment than it has with reference to its commercial equipment. It is generally conceded that no industry is so lacking in commercial development as is the electrical industry, but the same people who concede the above also concede that the development of apparatus and machinery for the generation and distribution of electricity have been no less than marvelous.

"By devoting a separate department to business schemes and methods, you will tend to increase the interest in such matters and this interest will be productive of results. Every member of the commercial department of a central station will make it a point to have Southern Electrician handy in order to obtain the latest information on commercial schemes. I wish to assure you that you have my complete co-operation and I will be constantly on the lookout for material which will be of interest to you."

Expressions follow from two central station new business managers having made successful records:

"In regard to a New Business Department for Southern Electrician I believe it can be made a very valuable department to both supply dealers and central station new business departments. I might suggest that such a department would be valuable, if certain space in it were set aside for selling schemes, copies of result-producing advertisements and window displays. Encourage the new business men and supply dealers to tell what has been done by them. You could gather complete data on all sorts of campaigns and each month reproduce one. For instance some company in the East, Baltimore, I believe, carried on a lighting campaign selling wiring, fixtures, lamps, reflectors and all, for so much per watt. The idea was unique and the results very gratifying. Our company, as you know, added 662 residence customers in six weeks' time. Wouldn't detailed outlines of such campaigns be worth considerable to new business men casting about for selling schemes? Show them just what ads were run, just how the men were handled, what prizes or compensation was paid solicitors, and what the campaign cost. The supply houses, too, are going after new business. Reproduce good window displays, for I think this is one point on which most dealers are weak. The use of educational material by central stations and supply dealers should also be encouraged. Education in electrical matters is the basis of increased business. I am sure a very valuable department could be worked out along these lines."

The second central station letter follows:

"In regard to your idea of establishing a new business department in Southern Electrician, I will say that this should prove very beneficial. Along this line of thought, if it is permissible, I would suggest that you get in touch with a dozen or more properly qualified commercial managers and obtain all the assistance possible before publishing your subjects. Of course, it goes without saying that you will do this but the point I have in mind is this: There are any number of magazines in the field today that devote considerable space to new business, or commercial departments, and on going over them you will find that there is a re-hash of many things that are ancient history, and by a study of these publications you will note that Smith resorts to some particular stunt in one section of the country, and fifteen or eighteen months later a similar article appears with photographs and description and credits Brown with springing something entirely new and original in an opposite section of the country. As a result there are many readers who glance over the commercial articles in these magazines and pass them up without careful reading under the impression that there is too much repeating. On the other hand, the commercial manager who believes he can keep abreast of the procession without reading the trade publications covering the subject is fooling himself. My advice on this subject is not to be considered a criticism, merely a suggestion that your efforts be directed and applied in a manner that will render the best assistance and command interest and attention to a greater degree than some of the articles now appearing under the head of 'New Business Departments.'"

We heartily appreciate such letters as the last one quoted. It will be our one aim to steer clear of conditions that will place us in the class mentioned. Should any sign at any time point to a tendency in that direction, you are officially appointed a wielder of the "big stick" and expected to act in a manner that becomes the originator thereof.

The particular subject taken up in this issue is one of long standing yet of particular interest, namely, "The Trade Relationship Between Manufacturer of Current Consuming Devices, the Electrical Dealer and Contractor and the Central Station. This problem is of such extreme proportions that it is impossible of solution by any one party alone. Few, if any, have been connected in a close way with every phase that the subject embraces. Each can therefore only hope to state the conditions that hold for a very small portion of a very small corner of the general subject. It is not therefore, with an idea of presenting an absolute cure for the existing evils that our ideas are advanced together with those of our readers; what is desired, however, and what must be done, is to bring about a concerted action of all parties interested and assist the agencies which in their own way are working with time to the final solution.

Electric Vehicle Investigation.

The Department of Electrical Engineering of the Massachusetts Institute of Technology has under way an important investigation on the adaptability of electric vehicles for trucking purposes, more especially with reference to the conditions in Boston and its vicinity. Mr. H. F. Thomson, the research associate in carrying on this work, is making substantial progress in the inquiry which is directed along several particular lines, including cost of the service, convenience of the service, difficulties and expenses due to the delays in loading and unloading at freight houses and the like, delays caused by drivers, and corresponding matters. The railroads entering Boston are cooperating with the part of the investigation relating to time occupied in loading and unloading trucks at the freight houses, including the time occupied in getting to the loading platform.

An appropriation for this work was made to the Institute by the Edison Electric Illuminating Company of Boston. The research was begun about the middle of the year 1911 and is expected to extend beyond the year, finally presenting a report or series of reports on the relative merits of electric vehicles, other mechanical vehicles and horse vehicles for city and suburban delivery, from the standpoint of trucking and for the other purposes for which vehicles are used in the city and its suburbs.

The Hydro-Electric Developments of the North Carolina Electrical Company.

(*Contributed Exclusively to* Southern Electrician.)

BY N. BUCKNER*.

Brief Description of Ivy and Weaver Plants With Details of Marshall Station Recently Completed.

THE past few years of Southern hydro-electric development have left the greatest physical indications of progress in the states of North and South Carolina. While to the work of the Southern Power Co., naturally, must be credited the progress in South Carolina, the work of its northern neighbors has been accomplished through smaller but no less important systems. In the state of North Carolina there seems to be three centers about which hydro-electric activity has centered, namely, Asheville, Charlotte and Raleigh. Asheville has and will handle the power transmission features in the mountain region, Charlotte in the Piedmont section and Raleigh in the East. In the territory of which Asheville is the center, it is said that 500,000 horsepower is available from the streams. Within a radius of 25 miles of this place there are already six hydro-electric developments, that of the Waynesville Light and Power Company, on the Pigeon River, that furnishing light and power for Brevard, the Asheville Electric Company's plant on Hominy creek in Buncombe county, and the three plants of the North Carolina Electrical Company, one on the Ivy River, one on French Broad River near Asheville, and the other near Marshall on the same stream. The North Carolina Electrical Company also owns the Mountain Island property near Hot Springs, which is capable of development with a capacity of about 10,000 horsepower. This company is well financed and has always kept in advance of the demands, being in a position at any time to furnish, at comparatively short notice, through additional plants, the power needed in the surrounding territory.

In this article the writer will take up briefly the developments of the North Carolina Electrical Company, describing more particularly the plant at Marshall, known as number three, recently placed in service. The work on the above company's plants began in 1900 with the construction of the Ivy dam known as plant No. 1. The Ivy plant was completed in 1901 and is located north of Asheville on the Ivy River. The dam is 120 feet long, 65 feet high, built of masonry, and the power house structure is of frame construction 28 by 46 feet. The water is brought to the wheels through iron pipe flumes, 6 feet in diameter. The electrical equipment of General Electric design is sufficient to develop 750 horsepower.

*Mr. Buckner is Secretary of the Asheville Board of Trade and an authority on the resources of Western North Carolina.

Fig. 1. View of Power House and Dam at Marshall Plant.

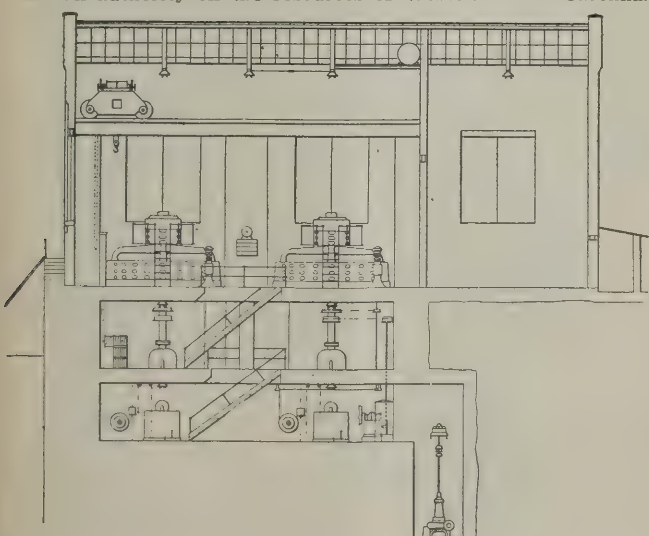


Fig. 2. Section Through Power House, Marshall Plant.

The Weaver Plant or Plant No. 2, was completed and put in operation in May, 1904. This plant is located a few miles north of Asheville and has a normal capacity of 3,200 horsepower. The dam is 606 feet long, 13 feet high, built of masonry, 12 feet thick at the bottom and 6 feet at the top. Water is carried to the wheels through a canal 3,800 feet long, 960 feet of which is built of masonry, the remainder of the canal being built of earth embankment. The power station building is of brick 52 by 100 feet with composite roof and is equipped with a twenty ton traveling crane. The water wheel equipment consists of a Hercules turbine manufactured by the Holyoke Machinery Company of Worcester, Mass., with two units horizontally connected to two 750 kw. generators, operating under a voltage of 6,600. One generator is of Westinghouse design the other of Bullock design. In addition there are two 56 kw. exciters directly connected to two 27 inch turbines, either exciter being capable of exciting the two generators. The plant as a whole represents an expenditure of $325,000.

The third hydro-electric development of the North Carolina Electrical Power Company of Asheville, N. C., the Marshall plant, located on the French Broad River twenty-five miles northwest of Asheville, has been in the course of construction for the past two years, and just been completed and put into service. The normal capacity of this plant is 5,000 horsepower, and the entire plant represents

in round figures an expenditure of $500,000.00. In constructing this development it was necessary to raise and rebuild two and a half miles of the track of the Southern Railway, which skirts the river at this point. The track at the dam was raised twenty feet higher than the old roadbed, the total excavation amounted to about 60,000 cubic yards, 80 per cent of which was solid granite. The change in roadbed alone cost $75,000, required one year to complete, and all work was done without interference with traffic, there being operated over this line an average of thirty to forty trains per day.

The dam is 540 feet long, 30 feet high, 43 feet 9 inches thick at the base, and 11 feet at the top. It is built of cyclopian concrete, the large stones in some instances approximating five cubic yards. Approximately 22,000 barrels of cement were used in the construction of the dam, foundation of power plant and retaining wall for protection of roadbed. The dowstream face of the dam is curved in such a manner as to insure the water always clinging to the surface and preventing the formation of a vacuum under the falling sheet, since it is generally conceded by engineers that a vacuum on the downstream side is responsible for the trembling often felt in the vicinity of overfall dams.

There are two 7-foot gates in the dam next to the power house, which are operated hydraulically and are opened and closed by an electrically driven pump in the power house. The gates and cylinders are entirely submerged. The four penstock gates are among the largest cast iron gates made; each gate covering a clear opening of 18 feet by 7 feet three inches and weighing thirteen tons. They are operated in pairs by an electric motor.

The power house, 40 by 76 feet, is of fireproof construction throughout, being built of concrete to the floor line, and brick from that point up. Windows are of steel and prismatic glass. From floor to eaves is 31 feet; from bottom of foundation to comb of roof 100 feet. A fifty ton electrically operated traveling crane extends the entire length of the building. The equipment consists of two 1875 kw. Westinghouse 3-phase, 60 cycle, alternating current generators, operating at 6,600 volts and 133 R. P. M. Each is directly coupled to two turbines made by the I. P. Morris Company. The units are vertical, with the exciters located on top of the generators. The entire control of the plant is from the switchboard, all gates, switches, motors and valves being electrically operated.

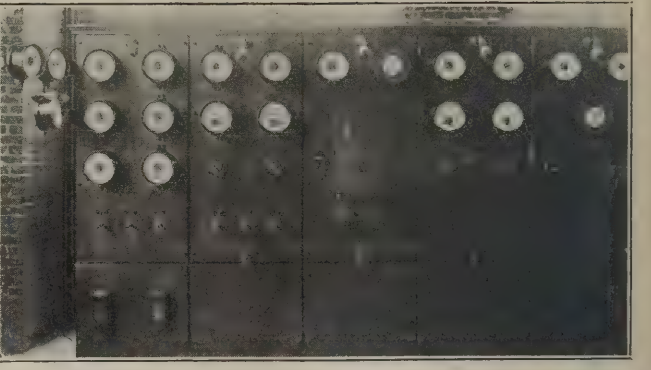


Fig. 4. Switchboard of Marshall Plant.

The power is generated and distributed at 6,600 volts the tie lines between the three plants operating at 66,000 volts. Duplicate power lines have been built on private right of way, one on west side, and the other on the east side of the river, to plant No. 2 of this company six miles northwest of Asheville, where there is a substation for distributing the power to Asheville, Canton and other places.

The other two hydro-electric plants owned by the company develop four thousand horsepower, nearly all of which has been utilized in and around Asheville. The new plant has been made necessary by the increased de-

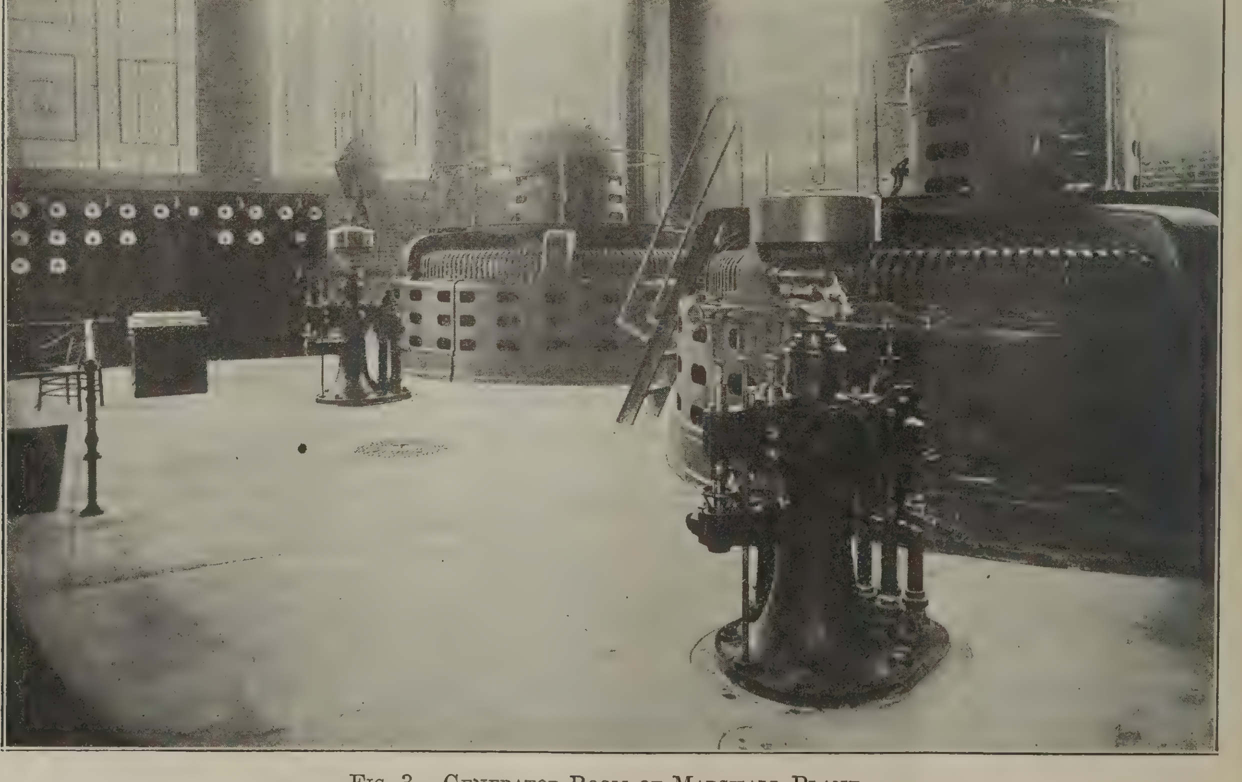


Fig. 3. Generator Room of Marshall Plant.

mand in Asheville, and surrounding territory for additional light and power. The North Carolina Electrical Power Co., supplies at present practically all of the power used in Western North Carolina, furnishing Biltmore, Asheville, Marshall, Canton, Weaverville and other small towns. The power is transmitted from the three main stations over about 80 miles of transmission lines.

ing the use and origin, as red braid is always neutral, common or negative, depending upon the circuit, white is invariably an instrument wire from phase a, black an instrument wire from phase c, or positive depending upon the circuit. The back of the switchboard is similarly arranged and connecting it up merely resolves itself into matching colors at respective cable ends. The large

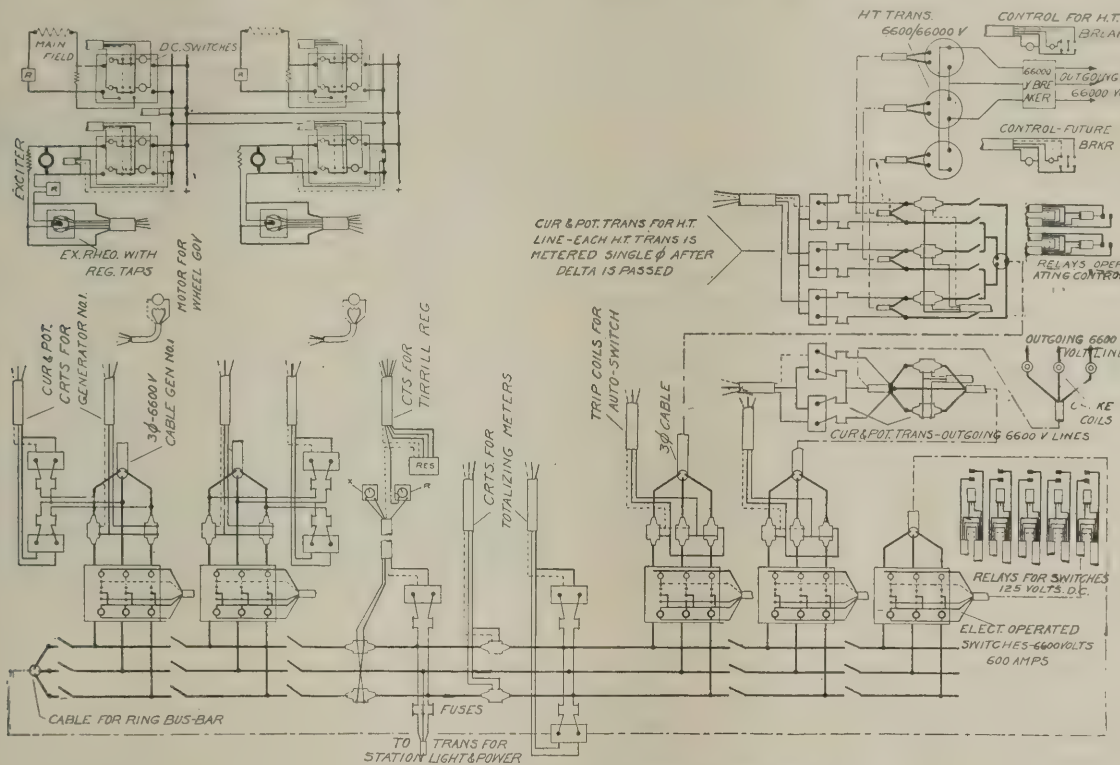


FIG. 5. WIRING SCHEMES OF MARSHALL PLANT.

The illustrations shown herewith give some idea of the nature of the development at Marshall, known as plant No. 3. The wiring diagram for this plant is shown in Fig. 5. As shown a ring bus is used and all wiring is in cable and conduit. The wires are multicolored, the color signify-

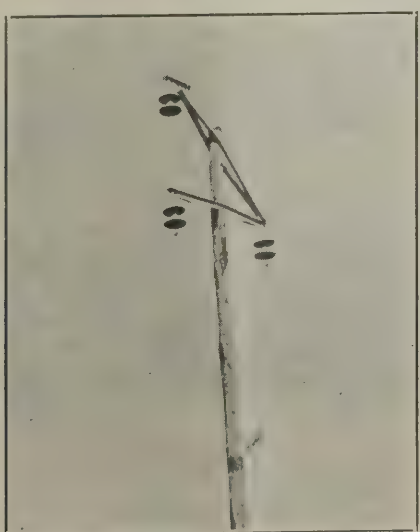


FIG. 6. SHOWING HIGH TENSION LINE CONSTRUCTION. POLES 40 FEET. SPANS 300 FEET. WIRE. NO. 0 ALUMINUM. INSULATORS, LOCKE, NO. 2297. WIRE SPACING 6 FEET, 6 INCHES. POTENTIAL, 66,000 VOLTS. DESIGNED BY C. E. WADDELL.

switches are electrically operated and the relays that handle the current in the solenoids are shown at the right in Fig. 5.

The potential maintained at the Asheville center of distribution is practically constant in spite of the load changes, this being obtained by a careful adjustment of several Tirrill regulators. No feeder regulators are employed. The frequency of the circuits is about as constant as the potential, the only variable factors on the circuits being the loads and power factors,. As in other similar connected plants, the power factor varies through wide ranges where a constant potential is maintained, however by shifting the wattless component from one generating station to another an average temperature of all machinery is easily obtained. The plants above described are unique in operation and somewhat different from the ordinary.

This plant was designed by Charles E. Waddell, member American Society Civil Engineers, also member American Institute Electrical Engineers, Asheville, North Carolina. Captain W. T. Weaver is president of the company and Charles Folsom is resident engineer.

Different oils have been tried in transformers, but at the present time mineral oil is used exclusively. A good grade of oil should show very little evaporation at 100 degrees C. and should not give off gases sufficient to produce an explosive mixture with the surrounding air with the temperature below 180 degrees C. It should, of course, be neutral and be free from acid or alkali reaction.

Instrument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively* to Southern Electrician.)
BY E. P. PECK, ASST. ELECTRICAL ENGINEER,
GEORGIA RAILWAY AND ELECTRIC COMPANY.

Section 4. Methods and Formula for Checking Watt-Hour Meters.

WATTHOUR Meters, frequently called recording wattmeters, are used in an electrical system for measuring the watthours generated and delivered. As these meters measure the whole amount of power sold, unless a flat rate is used, it is most important that they be kept accurate. Any error in these meters causes exactly the same per cent difference in the company's income. The equipment of a meter shop will of course depend on the size of the company and the number of meters handled. A very small company would probably have only a few standard meters, and a bench with a lamp bank of suitable size, wired up with switches to throw on various numbers of lamps. For large companies the arrangement described on pages 57 and 58, of the February issue in Section two of this article on "The Laboratory," would be very convenient and flexible.

The standard meters used in the meter department should be portable meters which are checked weekly by the laboratory. These portable meters should preferably follow the scheme laid out in Section 3 of this article on "The Care and Use of Portable Instruments." The capacities of the meters and the number of them, of course, depends on the character and the volume of the work.

Wattmeters in service should be checked at intervals, the length of these intervals varying with the kind of meter, its size and the class of service. Induction meters in residences and small business places may be checked every 12 months. Direct current meters on small loads and induction meters on large loads should be checked every six months. Meters on very large service may well be checked every three months, or even monthly. If a meter is subject to vibration and in some other special cases, it is advisable to make checks more frequently than would be done otherwise. All meters should be checked before leaving the shop. This applies to new meters and meters which have been moved from other locations.

TESTS OF METERS ON THE LINE.

The tests on the line are made with the meter in its permanent location, the tester making any small repairs or connections without taking the meter down. If the meter is greatly in error or requires extensive repairs, it should be replaced by another meter and taken to the shop to be thoroughly overhauled. A check should be made on all meters a short time after they are installed as they are very liable to change calibration when being taken out and installed.

A test on the line consists of three parts: First, a test is made on two or three loads to determine the accuracy of the meter. The loads chosen may be 5 per cent and 75 per cent of full load, or 10 per cent, 50 per cent and 100 per cent loads. This test should be made before the meter is cleaned up or adjusted in any way.

Second, a complete mechanical inspection should be made to see that the jewel and pivot, commutator and brushes, magnets and disc, etc., are in good condition and clean. The commutator and brushes should be cleaned and polished if necessary and a new jewel and pivot put in if the old ones are the least rough. The top bearing and gearing should be examined as they some times get gummed up or the pivots get rusty. It is well also to make a ground test at this time.

Third, a final adjustment of the meters should be made, the checks being on the same loads as before. The meter should be made as accurate as possible on all loads, the maximum allowable error from 10 per cent load to full load being 2 per cent on good meters. On 25 per cent, 50 per cent and 100 per cent loads the meter should be left within 1 per cent of correct. All meters are subject to change with use, hence the test "as found" will not show the same meter accuracy, and if found within 5 per cent of correct, the meter may be considered satisfactory. At least three readings should be taken on every point and if the readings do

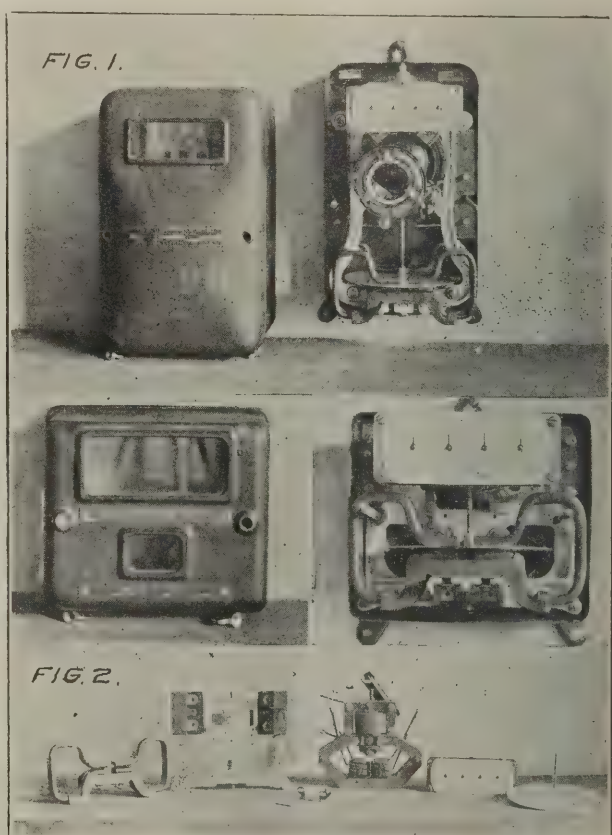


Fig 1. General Electric Type C. D. C. Watt-hour meter; Fig. 2, External Appearance and Parts of Type I, Same make.

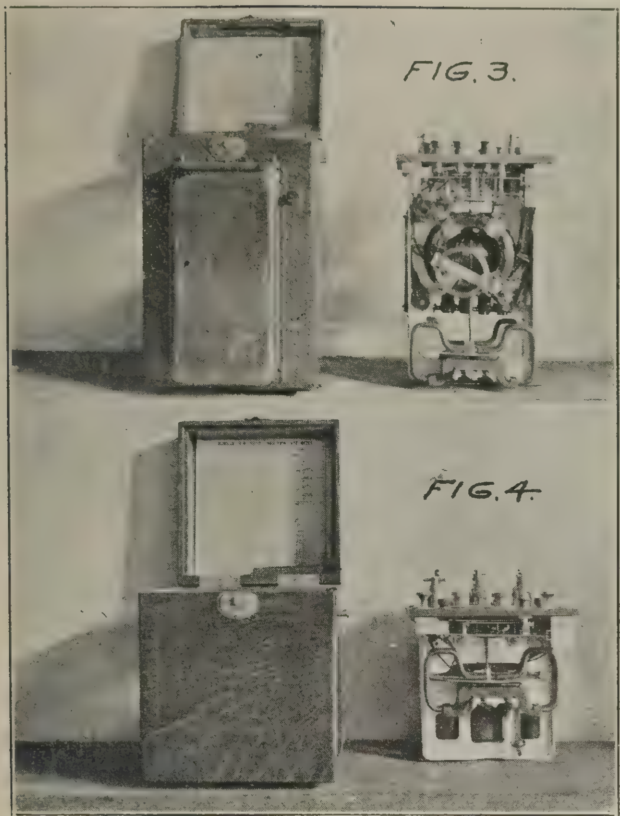


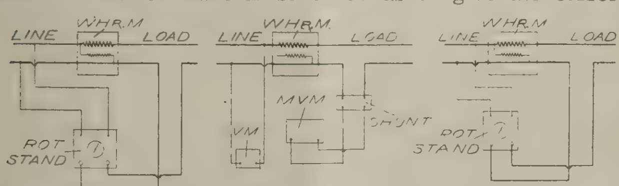
Fig. 3. General Electric D. C. Rotating Standard; Fig. 4. Same Make A. C. Rotating Standard.

not agree closely a larger number should be taken, the average of the readings being used as the result.

When adjusting the meter for accuracy, it is well to first make the meter as nearly correct as possible on half load or full load, depending on the average load the meter carries. This adjustment is made by moving the magnets. The meter should then be adjusted on 5 per cent or 10 per cent load with the light load adjustment, and afterwards checked on heavy loads again. Changing the light load adjustment slightly, should not change the heavy load adjustment appreciably. After adjustments are completed, the meter should be tried to see if it creeps on the potential alone. If it does not the calibration may be taken as satisfactory.

METER CONSTANTS AND FORMULA.

There are two constants in use on watthour meters, the dial constant and the disc constant. The dial constant is the number to multiply the dial reading by to convert it into watthours or kilowatthours. The disc constant is usually marked on the disc and is used when calibrating the meter. This constant is so taken as to give the correct



Connections for Checking 2-Wire D. C. Watt-Hour Meter with Rotating Standard and with Voltmeter and Milli-Voltmeter. Also Connections for Checking 2-Wire Low-Voltage Induction Watt-Hour Meter with Rotating Standard.

relation between revolutions per minute of the disc and watthours. The speed of the meter disc, at any instant, is proportional to the watts in the circuit, and if the watts are held constant the speed of the disc will be constant and the number of revolutions will be proportional to the load on the meter. The standard watts for a measured number of seconds equals the standard watt-seconds. The tested meter must record the same number of watt-seconds to be correct. Several manufacturers use the watthour constant for the disc constant, which means that the revolutions of the disc times the constant equals the watthours measured. Thus,

Watt-hours $= K \times R$ and,

Watt-seconds $= 3{,}600 \times K \times R$ hence,

Watts $= (3{,}600\ KR)/\text{Sec.}$

Where K is the disc constant and R is the revolutions of the disc for a certain time.

Other manufacturers use the watt-second constant as K, and the formula would then be, Watts $= (R \times K)/\text{Sec.}$

When the meter is made the constant K, is so taken that the meter runs a proper number of revolutions on full load. The constant once determined, the revolutions are then altered to make the meter record correctly, and any adjustments made are effected by changing the speed at which the disc revolves for a given load.

The formula may be written in the following forms which are useful when some factor other than the watts is to be known:

$W = (3{,}600\ K \times R)/S.$ $S = (3{,}600\ K \times R)/W.$

$R = (W \times S)/(3{,}600 \times K).$ $K = (W \times S)/(3{,}600 \times R).$

$3{,}600 = (W \times S)/(K \times R).$ Where W = Recorded watts; K = Disc Constant; R = Revolutions in seconds measured; S = Seconds meter ran.

If the meter is a direct current meter, or an alternating current meter checked with its transformers in circuit, the constant marked on the disc is used. If alternating current meter, supplied with current and potential transformers, is checked without its transformers, the calibrating constant is found thus.

Calibration K = (Disc Constant K)/(Cur. Trans. ratio $\times$ Pot. Trans. ratio).

THE ROTATING STANDARD METER.

It will be found most convenient and rapid to use rotating standard meters as the working standards on all regular meter testing both in the shop and on the line. A rotating standard may be set up in the shop and a large number of meters connected in with it and all of the meters calibrated at once. When this is done the shunt connec-

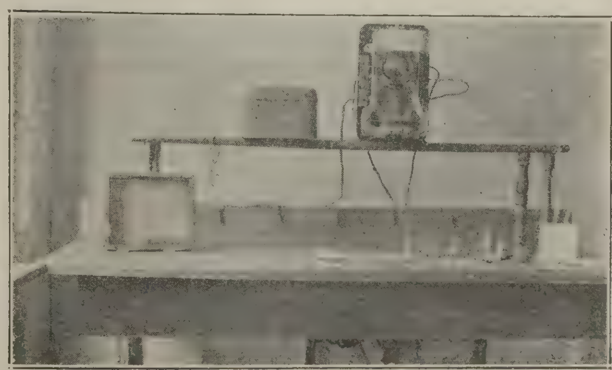
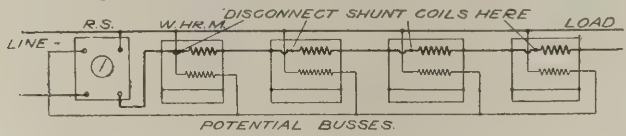


Fig. 5. Bench for Testing Watt-hour Meters With Rotating Standard Set in the Bench.

tions in the meters to be tested should be disconnected from the permanent connections and run to a separate lead as shown herewith, to prevent some of the meters from measuring the shunt field loss of others.



CONNECTIONS FOR CHECKING SEVERAL INDUCTION WATT-HOUR METERS, USING ROTATING STANDARD.

The rotating standard method of checking is particularly advisable for tests on the line as one tester may do all the work and checks may be made more rapidly than by using the indicating meter as standard. The rotating standard method is fully as accurate as the indicating standard method of checking and does not require the use of a stop watch. Voltage variations do not have to be taken into consideration when using the rotating standard as the standard and tested meters are affected in the same proportion. Continuous accuracy should not be expected of the rotating standard, and it should be checked frequently. Daily checks are advisable for these meters when in regular use on the line.

To test with the rotating standard, the meters are connected and allowed to run about 20 minutes to warm up. The load is adjusted to approximately the load wanted for test and the rotating standard meter started when the spot on the disc of the tested meter is passing some given point. The standard should be stopped when the spot on the disc passes the same point after the tested meter has run the chosen number of revolutions. The watts recorded by the tested meter may be figured by the formula $W = (3{,}600\ K \times R)/S$. The watts recorded by the rotating standard may be figured by the formula given on the meter case: $\text{Watthours} = K \times R$. As this result is in watthours and the meter ran 60 seconds, the watts are obtained thus: $\text{Watts} = \text{watthours} \div 60$. A correction must be applied for the error in the rotating standard. The per cent of error is obtained thus: $[(\text{Meter Watts})/(\text{Standard Watts})] \times 100 = \%$ accuracy.

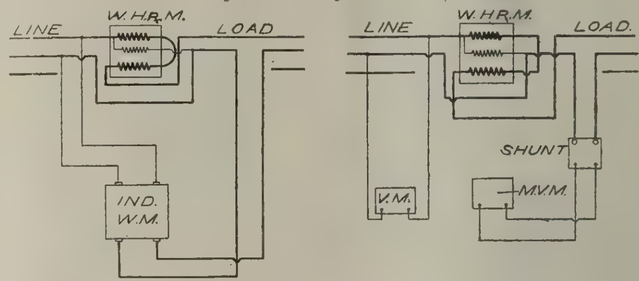
The work of making and writing up a test is much simplified by using a comparison of the number of revolutions of the rotating standard and the tested meter, instead of reducing both meter readings to watts. The revolutions the tested meter should make may be obtained from the formula $R = (W \times S)/(3{,}600\ K)$.

If the test meter should run 25 revolutions in 60 seconds on full load and the rotating standard should run 10 revolutions in the same time on the same load, a direct comparison of revolutions may be used for determining the meter error. Should the rotating standard record 10.1 revolutions while the tested meter ran 25 revolutions, the tested meter would be 1 per cent slow. The latter method is much to be preferred on account of the time saved, the method of reducing both readings to watts being given to make the theory of the test plain.

For figuring the accuracy on any load, the number of revolutions the standard meter should make, in the time the tested meter is running a given number of revolutions, is calculated.

Then % error = [Calculated. Rot. Std. Rev. — counted Rot. Std. Rev./Calculated Rot. Std. Rev.] $\times$ 100.

It may seem from the above that the calculations necessary when using the rotating standard are tedious and a large number required, but the different revolutions are figured once for all on each size and kind of meter and afterwards it is only necessary to refer to the table. In



CONNECTIONS FOR CHECKING 3-WIRE LOW VOLTAGE SINGLE-PHASE INDUCTION WATT-HOUR METER USING INDICATING STANDARD WATT-METER, CURRENT COILS IN SERIES. ALSO CONNECTIONS FOR CHECKING 3-WIRE D. C. WATT-METER, CURRENT COILS IN SERIES.

fact a table is supplied with some standards which gives all data necessary for testing all common makes of meters and all of the above calculating is dispensed with.

CHECKS WITH INDICATING METERS.

For checking the rotating standards and for some special tests on watthour meters, indicating meters are used. The voltmeter milli-voltmeter and shunt are preferable for direct current tests, and the indicating wattmeter for alternating current tests. When checking watthour meters with either set of standards the formula for watts, given earlier in this article, is used. If there are any errors in the standard meters, care should be taken to make corrections for them. The desired load is held on the indicating meters and the revolutions of the tested meter disc are counted. The number of seconds for the counted revolutions are taken by a stop watch. The number of revolutions and seconds for each load may be calculated by the formula given above. The readings may be reduced to watts and the error obtained from a comparison of the recorded and standard watts.

That is % Error = [(Std. Watts — recorded watts)/Std. Watts] $\times$ 100.

A more convenient method of figuring the error is to compare the observed seconds and calculated seconds for the revolutions and load taken and use the formula:

% Error = [(Calculated seconds — observed sec.)/Calculated sec.] $\times$ 100.

MEASUREMENT OF TIME IN TESTING.

A stop watch is necessary for accurate tests with indicating meters unless some more accurate way of measuring time is used. A meter on test should run for at least one minute for each check and an error in timing of 0.3 of a second is a ½% error on a 60 second check. If the second hand of an ordinary watch is used, it is impossible to get results as close as they should be unless the check is run for several minutes. A stop watch if used should be frequently checked as the hand often jumps ahead or backwards a fraction of a second when started. *The accuracy of the measurement of time should be at least as high as the accuracy of the electrical instruments.* The importance of this point has been realized by a number of the larger companies and several of them have installed elaborate timing devices run from a master clock. Some of these give signals at one minute intervals and some operate to close the meter circuit for a given number of seconds.

Central Station Means for Stimulating Illuminating Engineering.

BY LLOYD GARRISON, ILLUMINATING ENGINEER.
(*Contributed Exclusively* to Southern Electrician.)

Co-operative Work of Illuminating Engineer With Supply Dealers and Electrical Contractors. Suggestions for Work Among Customers.

ONE of the most important developments is progressive central station work, and one that has been practically coincident with the development of high efficiency lamps, is that along illuminating engineering lines. Alert commercial men were quick to learn that the new lamps were rather than a danger, a means of effecting a much needed improvement in lighting conditions and of wresting valuable business from competitive illuminants. The central station business is essentially permanent and staple in character, for which reason policies must be adopted which insure results of like nature. It was to bring about results of permanent good to both the customer and the company that some of the more progressive central station companies began a scientific study of lighting conditions through engineers employed for that purpose.

Most of the research work in illumination done in the last few years has been carried on in the laboratories of the manufacturers of lamps and glassware, but the results obtained in such work have been given freely to the central station and retailer. It is the function of the central station illumination expert to so use and direct the use of this information that the greatest good is secured to all parties concerned. To secure these results, there must be harmony and concerted action between all who are concerned in presenting the subject to the public. There is little difficulty in securing co-operation between the manufacturer and the retailer, or between the manufacturer and the central station; it is sometimes hard to secure concerted action between the central station and the retailer. The general public has been accustomed to refer its illumination problems to the retail supply dealer and will continue to do so as it is impossible for the central station to reach all its customers in a way which is thoroughly satisfactory. Still there are few men engaged in retailing lighting supplies who are illumination experts. The first step of the illuminating engineer in his endeavor to better lighting conditions is, then, to secure the cooperation of the retail supply dealers. Few of these will fail to respond if approached in a tactful and sincere manner, and with the response will appear a desire for further and more definite knowledge. Concerted action with the retailers soon produces a unanimity of suggestion and recommendation that is one of the most potent factors in furthering the interests of both the retailer and the central station; but without this condition the customer is unable to decide between conflicting opinions, which latter condition cannot fail, by the atmosphere of distrust which it creates, to cause injury to the work as a whole.

After the illuminating engineer has brought the retail men into accord with the proper ideas regarding lighting, the problem of improvement can be attacked to the very best advantage. Under these conditions ordinary work is handled in a very satisfactory manner by the ordinary contractor, for usually these men can see that work of good quality pays best for all concerned in the long run. Thus the engineer is left free to care for particular cases; also to devise methods for securing increased business and a general improvement of conditions.

Perhaps the most efficient method of creating and maintaining interest in the last two points is that of mingling constantly with the customers, making suggestions, and keeping more or less constantly in the mind of the customer thoughts regarding the value of light. The exact methods of doing these things must, of course, be determined by the man doing the work; however, there is one method of creating interest and confidence which the writer has found more effective than any other and which may be valuable to others who find it hard to secure the ear of a prospective customer. This is the taking of illumination tests on the customers premises. An illuminometer of fair accuracy can be built for such tests which is so simple that any customer can understand its mode of operation. It is the latter point that is of the chief value, but at the same time valuable information can be secured for future reference or comparison.

As will be seen from the sketch, the instrument consists simply of a sliding mirror M which reflects the light from a standard lamp S on to the grease spot screen V, by means of which a comparison is made of the external illumination with that caused by the standard. The two mirrors R serve to show the observer both sides of the screen, the lower one being viewed through the slit H. The lower mirror serves also to screen the direct rays of the standard from V. Black velvet is used to line the interior and a flap protects the slot P through which the holder for the mirror M enters the box. This holder is supported and guided by the rod T along which a scale is placed to show the total distance of S from V. With a box having a total extension from S to V of from 12 to 50 inches the amount of light reaching V is from 70 per cent at 12 inches to 94 per cent at 50 inches. These values can be obtained by using two standard lamps or a standard lamp and a common lamp, the two being interchanged. Screens can be made from a good grade of white bond paper by the use of a fairly sharp edged iron dipped in hot paraffin. The print should be pressed dry with a hot iron and blotting paper.

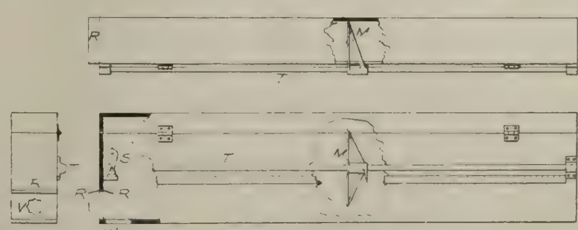


Fig. 1. A Useful Illuminometer.

Many central stations still advance the old time view that they have no interest in their product after it passes the meter and that they should not be put to any expense to better their customer's conditions. That this is a fallacious view is evidenced by the disrepute into which the public service corporations have brought themselves by their short-sighted, grasping methods, and by the popularity and freedom from censure enjoyed by such companies as have proven that they have the best interests of their clients at heart.

The illuminating engineer is one of the most efficient mediums of transmitting to the customer the good intentions of the company; his best advice given as it is to customer after customer, and backed up by other interests engaged in lighting work, cannot fail to arouse a feeling of confidence and satisfaction which is not alone valuable in securing additional business but is a first class insurance against many kinds of competition. Central station companies are coming to realize more and more the value of this sort of thing. It is an asset none the less real because intangible, and public spirit is an excellent advertisement both for the central station and for the community which it serves. It is to be hoped that central station companies will join heartily in the national movement for the betterment of lighting conditions now in progress.

Conduit Considerations for Underground Distribution Systems.

(*Contributed to* Southern Electrician.)

BY WILLIAM D. LIGON.

A Review of Developments in Underground Distribution and Engineering Features of Tile and Fibre Conduit Systems.

THE history and development of underground systems of distribution, while extending over a comparatively short period of time, is filled with interesting changes, not only in methods of construction, but also in materials entering into the work. No attempt, however, will be made here to cover the many points involved, for the object of this article is to present a comparison between the two more important types of conduit on the market today, namely, tile and fibre conduit, respectively.

The first underground system of distribution was undertaken in 1886 and during the twenty-five years which have elapsed many changes and improvements have been made, and today subway systems have come into general favor because of the permanency of construction, assurance against interruption to the service and low maintenance and depreciation charges. Aside from these advantages, the streets and thoroughfares are improved by the removal of poles and wires which detract greatly from the general appearance of city and country. The remedying of such conditions heretofore has been slow and in a measure was due to the lack of sufficient cost data in the hands of telephone, telegraph, railroad and central station officials. The appreciation, therefore, of subway distribution to both community and company has been slowly recognized; and as the advantages have become better understood the agitation against aerial lines has turned into a co-operative movement whereby the benefits are well appreciated, resulting in the rapid adoption of the subway distribution of electric currents wherever possible.

Like everything else in the electrical field, many improvements have been made in conduit materials, as well as in cables, to meet the more severe conditions of service resulting in changes in the types first employed, and it will be found that of the seven types of conduit developed, only two are now in general use. It may also be interesting to name the conduits first employed as follows: (1) The "Edison Tube System," consisting of iron pipe about 18 feet in length, through which the cables were drawn and the tubes filled with an insulating compound. (2) "Troughing," constructed of planks nailed together, in which the cables were laid and protected by an insulating compound, in the same manner as in the Edison Tube System. (3) "Cast Iron Multiple Trough," which was simply a substitute for the wood troughing named above. (4) Wrought iron pipe enclosed in concrete. (5) "Pump Log," made from soft wood, machined out to the proper dimensions and then creosoted. (6) "Single and Multiple Duct Tile," formed from clay in 18 and 36-inch lengths, respectively. (7) "Fibre Conduit," made from wood pulp, in 54 and 60-inch lengths and indurated with a bituminous compound.

The introduction of high voltage circuits and their protection has had a marked influence in eliminating the older types of ducts, although "Pump Log" is still used by telephone companies for conveying cables in suburban and country districts. The disadvantages of the older types are numerous and aside from rendering little protection to the cables, were expensive in first cost and did not possess lasting qualities, thus increasing the depreciation and maintenance charges to an unreasonable degree. The latest and most important development in the art is the introduction of fibre conduit, which was brought about as a result of the exacting conditions of present practice and the necessity of absolute protection of circuits from the dangerous effects of electrolytic action.

MULTIPLE AND SINGLE DUCT TILE.

This style of duct has been in use for about twenty-five years and is manufactured from vitrified clay in single duct, and multiples of two, three, four and six ducts in either round or square bore. The ducts are laid end to end, with dowel pins to hold in alignment, and usually surrounded with an envelope of concrete about 3 inches in thickness, as protection and re-enforcement to the entire structure. Joints are staggered and wrapped with either burlap or iron and cemented with mortar. This material, if properly vitrified and glazed, will last indefinitely. When free from iron it possesses high insulating properties, and costs less per duct foot, f. o. b. factory, than any other con-

duit on the market today. It also possesses great mechanical strength and shows an average puncture test of 25,000 volts dry and 21,000 volts after immersion in water for 150 hours.

While the dielectric strength of tile is very high, the insulation of a system is greatly lowered, in consequence of the large number of joints to be closed with cement or other moisture absorbing material, and instead of the entire system testing out at 21,000 volts it will be found, when taking the joints into consideration, an installation

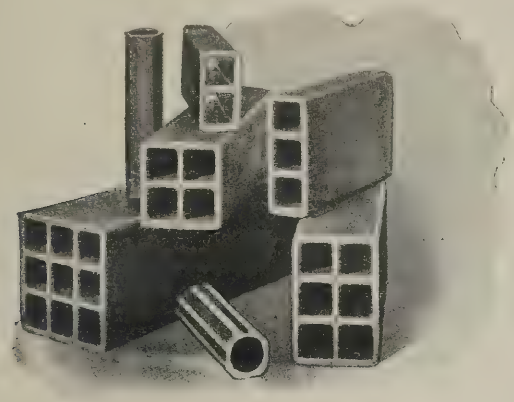


FIG. 1. MULTIPLE DUCT TILE CONDUIT.

will rarely show a dielectric strength greater than 5,000 volts, depending, however, on the general characteristics of the earth surrounding the ducts. In making the joints in multiple duct tile, it is impossible to prevent communication between the ducts, and due to this condition multiple duct affords the lowest protection to the cables and the action of electrolysis is more liable to occur than in single duct installations. The weight of 3½-inch tile is approximately eight pounds per duct foot and the heavy weight, therefore, increases the cost of freight, handling, carrying and laying, and in propositions involving the use of tile the question of breakage is also an important item of consideration and may often amount to as much as one-tenth of the total shipment.

Due to off-sets, seams and roughness at the joints, extreme care must be exercised in pulling through the cables to prevent abrasion to the sheath, and if cables are not installed properly, short circuits and cable troubles will be encountered, resulting in shutdowns and expensive repairs, which increase the operating expenses to an excessive degree in the course of a year. Few manufacturers of vitrified clay recommend the use of tile bends in subway distribution, due to the roughness of the interior, and it therefore becomes necessary to replace with manholes or hand

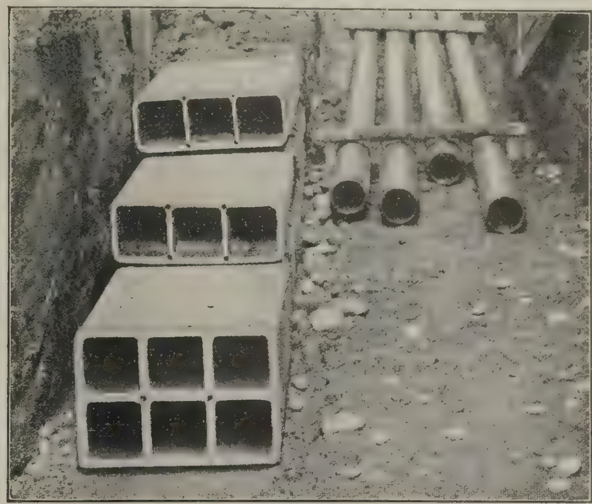


FIG. 2. MULTIPLE DUCT AND FIBRE CONDUIT INSTALLED.

holes, which increases the cost of the entire system. It has been demonstrated by experience that the cost of subway installation where tile is used for conveying the cables is considerably higher than the same installation with the newer type of material, due to the necessity of employing a higher class of labor, and the large percentage of duct which is furnished without true ends, and with seams, off-sets, blow-holes and improper glaze, and to these causes as well as others mentioned above, fibre conduit has rapidly come into general favor.

FIBRE CONDUIT.

Fibre conduit is the most recent addition in materials for subway distribution systems that has been developed to meet the new conditions of service. It has been in use about eight years and is formed in cylindrical shape from fibre or wood pulp under pressure. The wood pulp is thoroughly saturated with a bituminous compound and any vegetable matter or bacteria which would tend to promote

Table Showing Cost to Construct Single Duct Tile Conduit in Streets Paved with Granite, or Equivalent Paving, Exclusive of Manholes.

Duct Sections.	1	2	3	4	6	8	12	16	20	25
Excavation, Refilling, Paving and Removing Surplus Earth	$ .259	$ .353	$ .494	$ .430	$ .536	$ .722	$ .788	$ .858	$ .996	$1.072
Concrete	.105	.145	.185	.192	.239	.287	.348	.412	.474	.540
Cost Tile Delivered	.054	.108	.162	.216	.324	.432	.648	.864	1.080	1.350
Laying Tile	.030	.060	.090	.120	.180	.240	.360	.480	.600	.750
Cleaning Ducts	.005	.010	.015	.020	.030	.040	.060	.080	.100	.125
Water, Bridging and Shoring	.005	.007	.010	.012	.020	.025	.030	.040	.050	.062
Tool Repairs and Replacement	.010	.010	.010	.012	.020	.025	.030	.040	.050	.062
Incidentals	.010	.010	.010	.010	.012	.015	.018	.024	.030	.037
Supervision, Inspection and Time-Keeping	.036	.053	.073	.076	.102	.134	.171	.210	.253	.299
Total per Trench Foot	.514	.756	1.049	1.088	1.463	1.920	2.453	3.008	3.633	4.297

decay is killed by the presence of about 6 per cent of creosote salts in solution. There are at the present time two types in general use, known as straight joint, bell and spigot joint conduit, made in four styles of joint to meet the general conditions of service, namely, socket (mortise and tenon) joint, sleeve joint, drive joint and screw joint, furnished in from one to four-inch sizes. It has been shown that fibre conduit will stand an average puncture test of 32,000 volts dry and 24,000 volts after immersion in water for 200 hours.

Table Showing Costs of Constructing Multiple Duct Tile Conduit in Streets Paved with Granite, or Equivalent Paving, Exclusive of Manholes.

Duct Sections.	1	2	3	4	6	8	12	16	20	24
Excavating, Refilling, Paving and Disposal of Dirt	$ .230	$ .361	$ .546	$ .397	$ .559	$ .590	$ .637	$ .791	$ .867	$ .939
Concrete	.104	.131	.152	.160	.192	.243	.269	.333	.368	.384
Cost Tile Delivered	.053	.106	.159	.212	.318	.424	.636	.848	1.060	1.272
Laying Tile	.030	.040	.060	.080	.120	.160	.240	.320	.400	.480
Cleaning Ducts	.005	.010	.015	.020	.030	.040	.060	.080	.100	.120
Water, Bridging and Shoring	.005	.007	.010	.012	.020	.025	.030	.040	.050	.060
Tool Repairs and Replacement	.010	.010	.010	.012	.020	.025	.030	.040	.050	.060
Incidentals	.010	.010	.010	.010	.012	.015	.018	.024	.030	.036
Supervision, Inspection and Time-Keeping	.036	.052	.072	.072	.095	.114	.192	.247	.292	.339
Total per Trench Foot	.483	.727	1.034	.975	1.366	1.636	2.112	2.723	3.217	3.690

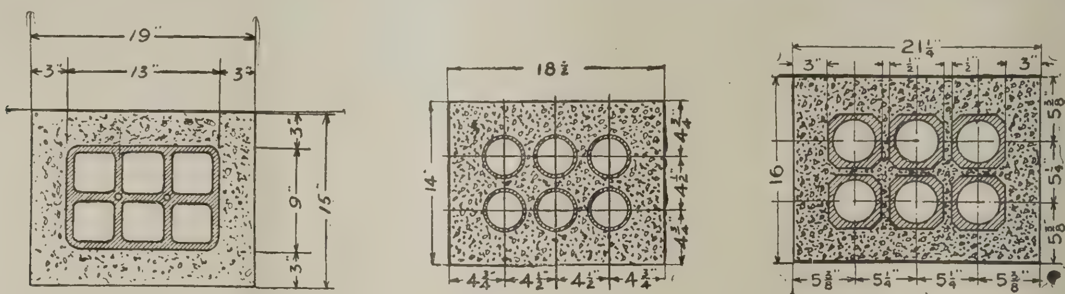


Fig. 3. A Comparison of Space Taken up by Tile and Fibre Conduit.

In the introduction of this material on the market there were objections to be overcome, the most serious being as to the life compared with the older styles of conduit which had been tried out, and during the eight years of development this point has been one of greatest discussion and observation, resulting in numerous laboratory and service tests. Samples recently excavated from the first installations show no deterioration, either mechanically or electrically, and while it is safe to say that fibre conduit will last indefinitely, no one is in position to tell whether impregnated fibre will last for more than fifty years, and in basing our calculations on the future, the only thing to do is to cite cases which are similar as possible.

It has been found that about 90 per cent of all cable troubles are directly traceable to some injury to the lead casing when being drawn into the duct, due to the roughness of the walls, and the cement which has seeped through the joint and formed cutting edges after hardening. Cable

Table Showing Cost to Construct Fibre Pipe Conduit in Streets Paved with Granite, or Equivalent Paving, Exclusive of Manholes.

Duct Sections.	1	2	3	4	5	8	12	16	20	25
Excavation, Refilling, Paving and Removing Surplus Earth	$ .230	$ .343	$ .431	$ .381	$ .481	$ .601	$ .655	$ .716	$ .848	$ .919
Concrete	.090	.126	.163	.175	.224	.273	.344	.417	.490	.572
Cost Fibre Pipe Delivered	.051	.102	.153	.204	.306	.408	.612	.816	1.020	1.275
Laying Fibre Pipe	.010	.020	.030	.040	.060	.080	.120	.160	.200	.250
Proving Ducts	.003	.005	.007	.010	.015	.020	.030	.040	.050	.062
Water, Bridging and Shoring	.005	.007	.010	.012	.020	.025	.030	.040	.050	.062
Tool Repairs and Replacement	.010	.010	.010	.012	.020	.025	.030	.040	.050	.062
Incidentals	.010	.010	.010	.010	.012	.015	.018	.024	.030	.037
Supervision, Inspection and Time-Keeping	.031	.047	.061	.063	.085	.101	.138	.169	.205	.243
Total per Trench Foot	.440	.670	.875	.907	1.223	1.548	1.977	2.422	2.943	3.482

troubles are also due to high currents leaking through the joints, as a result of improper installation and the impossibility to secure perfect alignment. These objections, by the use of fibre conduit are fortunately eliminated due to the smooth interior and water-tight joints. Unlike joining tile conduit, the connection made with fibre conduit is ideal, affording perfect alignment without the use of mandrels or dowel pins, and not having to use cement, mortar or burlap at the joints.

It is also true that fibre conduit is impervious to moisture, gases, acids or other corrosive elements, thus water, gas and stray currents cannot reach the cable protected by this material. It is a good non-conductor, doing away entirely with the trouble with stray currents, and is also an absolute prevention against electrolysis, which destroys many cables, gas and water pipes during each year. It is known that a pressure of five volts will destroy a water pipe or cable in about nine years, and there are few railways, light and power companies, who have not been troubled with electrolysis. In the event of short circuit the wall immediately surrounding the arc may char but the fire will not spread, resulting in the easy removal of the cables from the ducts.

In considering, therefore, the merits of the two more important materials for underground systems of distribution, it must be understood that each has its important field, and the conditions which govern these installations are to be considered carefully from the standpoint of interest and depreciation on the investment and the best service that can be obtained without interruption. The question of mechanical strength of fibre or tile when laid in concrete is of little importance, as the best concrete today will stand a compression test of about 3,000 pounds to the square inch, which is ample to meet the most exacting conditions of service.

Comparative Advantages of Gas and Electricity for Lighting.

(*Contributed Exclusively* to Southern Electrician.)

BY ALBERT SCHEIBLE, M. E. RESEARCH ENGINEER.

IN the struggle of competition, the offer of goods at lower prices may bring the orders for a time, particularly from among those who do not know how to estimate the real value of what they are buying. But for the discriminating buyer who knows how to judge what he is getting and who sees through the old trick of offering him much lower values at only slight reductions in the prices, the alleged saving is not enticing. He knows that paying ten per cent less for what is really worth only three quarters as much, means no saving to him, but rather obliges him to pay more in the end. He also realizes that where a number of items are used in connection with others, an apparent saving in the cost of one of these may be more than offset by the increased cost to which he is put for the others. So while each year may develop some who are not shrewd enough to properly judge of all the factors on which the real value of their purchases depends, most buyers in time learn the wisdom of paying for the truly economical even though this may at first glance seem to be more costly than the alternatives offered to him for the same general purpose.

While this struggle for the supremacy of the fittest has been warmly carried on for decades in the mercantile and manufacturing lines, it still is no less noticeable in the field of lighting where gas, acetylene and at times even gasoline keep diverting some from the patronage of the electric light companies. Usually such trade booked by these competitors is obtained squarely on the ground of lower costs, it being assumed that what is thus furnished the consumer will answer his purpose even though not on a par with what the central station would furnish at a somewhat higher estimated cost. In the case of gasoline and acetylene lamps the increased insurance risk, together with the difficulty of using reflectors to obtain a really efficient distribution of the light, readily offset the proffered cut in the price. With gas, the difference in the fire risk is not so great in the case of the average user of light, though sufficient to restrict its use in lines where the goods are inflammable and where the merchant realizes that even a dollar for dollar settlement of a fire loss by the insurance company would leave him with a heavy loss due to the shutting down of his store during the needed adjustment and overhauling.

But there are other factors that enter into the race between electricity and gas, for such it has been for several decades. The poor efficiency of the early types of incandescent lamps made them costly units for indoor lighting and while they held their own with the flat, fish-tail gas burners, the advent of the more efficient Welsbach mantels put the incandescent electric lamps at a decided disadvantage as far as the cost for a given effective unit of light was concerned. Had the tungsten lamp been developed simultaneously with the Welsbach mantle, the latter would never have gained its present foothold. But the commercial tungsten lamp came some years later than the gas mantle. Indeed, it was the work of Dr. Auer von Welsbach and some of his European colleagues in learning how to utilize some of the rarer metals that helped to perfect the commercial tungsten lamps of today. (In this connection it is interesting to note that the European Welsbach companies have themselves gone into the manufacture of tungsten lamps, thus showing how they appreciate the tendencies of progress in lighting.)

Thanks to the many years during which the gas companies had in the mantle burner a small lighting unit which the electric light people could not duplicate in efficiency until the advent of the tantalum and tungsten lamps. Some members of the gas fraternity became imbued with the idea that they held a permanent advantage over their electrical competitors—an idea which they have been slow to outgrow. Even today, many of them are loth to admit some of the handicaps under which they must work in competing with electric lighting; indeed, there are some whose loyalty to their cause has carried them to the extent of declining

to see any such disadvantages. Then, to cap the climax, we occasionally find a staunch gas advocate who even claims a superiority for gas lighting over electric lighting, regardless of the usual question of price. Sometimes these pleaders base their arguments on tests purporting to show a superiority of the gas lamps over electric lights; more often they confine themselves to general, but emphatic statements, leaving it to their competitors to disprove the same. In several cases the experiments from which conclusions have been drawn to the evident advantage of the gas fraternity, have been made by men of high standing and have been so widely quoted that it will not do to simply ignore them. Indeed, the whole repertory of the modern gas advocates' claims deserves to be noted by users of light, hence it may be well to review some of the points likely to be raised by the shrewd gas solicitor:

DIMMING THE LIGHT.

In the days when the struggle was between the fishtail burner and the carbon filament lamp, this meant an evident advantage for the former. With the mantle burners, the dimming is not so easily done without running the risk of having the dimmed light blown out by a sudden draft—a risk which is always run with gas lamps, whether dimmed or not. Besides, it is not always easy to turn a gas burner down without putting it out altogether, unless the burner is of the chain type and properly adjusted to the prevailing pressure. On the other hand, an incandescent lamp can instantly be turned on or off by a touch of a wall switch and with a large percentage of lamps there is no real need of a dimmed light. Usually either the full effect of the lamp is wanted, or none, and the wall switch is far more easily operated than a chain pull. Besides, such switches can allow the lights to be turned on in various combinations. For the comparatively rare cases where a dimmed light is really advisable, dimming lamps or dimming attachments for the sockets, are to be had in several different styles. Or, a low candle power lamp on a separate switch (or on separate wires of a multi-circuit switch) will serve the purpose and will allow the lighting to be cointrolled from a convenient point on the wall.

WALL CONTROL.

Attempts to operate gas lamps by wall control switches have been made repeatedly and in some cases with a fair degree of success. For instance, the powerful groups of gas mantles used in and about the offices of the Peoples Gas Light & Coke Co., in the new Peoples Gas Building at Chicago, are turned on and off by applying a small pump (similar to that commonly carried by cyclists) to the outlets of tubes in a wall box. This does the work, but is both cumbersome and slow as compared with the pushing or turning of an electric switch, as the gas lamps take fully a minute to light up after the tube has been pumped up.

ADAPTABILITY TO DIFFERENT LOCATIONS.

Since the introduction of the inverted mantle burners, it has been feasible to place these closer to ceilings than was possible with the upright mantle or fishtail burner. To the gas fixture maker, who had grown accustomed to keeping the burners at a respectful distance from the ceiling, the ability to bring them within six or eight inches of the latter meant a great reduction in the former limitations of the gas burners. In some quarters, this has been interpreted as implying that the gas lamps are now as adaptable in the range of their positioning as the incandescent electrics. However, this is far from true. With few exceptions, the gas lamps must always be placed in a vertical position and at a considerable distance from ceilings and walls, while the modern tungsten lamps can be used in any position and not only placed close to the walls or ceilings but even set into the same if desired. As a result of this difference, the tungsten lamps readily lend themselves both to artistic effects beyond the range of gas lamps and to the lighting of show windows, etc., in which the height needed above the gas burners would prohibit their being placed where the lights would be most effective.

ADVANTAGEOUS USE OF REFLECTORS.

In many clases of work, such as show window lighting, the economical use of tungsten lamps has depended to a considerable extent on the adoption of reflectors which would direct the light where it is needed. Among the most efficient of these reflectors are some made of mirror glass which will not stand the heat of the gas burners if brought as close to the latter as the reflectors are commonly brought to the tungsten lamps. Consequently, the reflectors available for use with gas burners are much more limited in shapes and efficiency. Moreover, the sulphurous products of the gas combustion, although usually not large enough to be detected by the sense of smell, are sufficient to gradually tarnish the silvering on the reflectors unless this is uncommonly well screened against such action by an impervious coating.

At the same time, the strong air currents created by the gas burners draw a much larger amount of air past the reflectors during each burning hour than would pass the same reflector if used with a tungsten lamp of the same candle power. If the air were clear and the sources of light at the same temperature, this might mean an advantage for the gas burner as it would imply a greater cooling action upon the reflector. But the much higher temperature of the gas mantle more than offsets any such cooling effect and the increased amount of dust and soot deposited by the air currents upon the reflector reduces the efficiency of the latter.

Besides, the irregular expansion and contraction effects due to the intense heat, the varying air currents usually lead to a breakage of glassware not met with electric lamps. In the case of mantle lamps, this is rarely confined to the chimneys immediately surrounding the mantle, but more often extends to the reflectors, globes or shades also.

This subject will be continued, when other features of gas and electric lighting will be compared.

Conservation of Water Power.

Investigations of possible sites for developing water power on the public domain are being pushed by the United States Geological Survey, with resulting withdrawals of land from entry where it is found that valuable sites exist. In July 31,725 acres of such land were withdrawn, including a great number of power sites. No estimate has been made of the horsepower involved, but owing to the character of the power sites withdrawn it is believed to be very large. These July withdrawals make a total outstanding area withdrawn of 1,546,258 acres, based on the examination and recommendation of the Geological Survey, and involving thousands of power sites and doubtless millions of horsepower.

Engineering Considerations in Installing Residence Electrical Equipment.

Representing Recommendations of National Electrical Contractors Association, National Electric Lamp Association, National Electric Supply Dealers Association and Commercial Section of National Electric Light Association.

Practical Data and Suggestions for Architects, Electrical Contractors and Central Station Engineers.

AS an example of the service that is being rendered cooperatively by the associations representing the various fields of electrical activity, we present herewith an abstract of material published by the National Electrical Contractors Association, National Electric Lamp Association, National Electrical Supply Dealers Association, and the Commercial Section of the National Electric Light Association. The information has been compiled especially for architects, builders, electrical contractors, central station representatives, and those planning a home, for the purpose of showing that by a careful and liberal consideration of the first installation of wiring, equipments may be so planned as to permit a gradual expansion, where required, at a minimum cost. In view of the fact that close competition in the figuring of wiring costs has often compelled contractors to so install equipment that any increase in service requirements has necessitated alterations in the installation rather than additions, the usefulness of the information from all standpoints is readily recognized. The proper initial installation prevents a high cost of an extra outlet, and therefore tends towards a widening of the market for electrical wiring, electrical heating and cooking devices, a benefit to central station, electrical dealer and contractor.

The electrical contractor and the central station man at the present time both realize that the electric light is only one of the many home applications of electricity and that every home should, and ultimately will, be equipped for complete and comfortable service. A general review of the varied applications of electric service, room by room, will suggest many details which mean much in practical comfort. In the following synopsis the same device is purposely mentioned as being appropriate for use in more than one room. This does not imply duplication of equipment, but simply that the appliance might be exceedingly convenient and appropriate in various parts of the house and that facilities should be provided for connection.

LIVING ROOM. In the living room, requirements for illumination are quite severe. It is therefore essential that there be several sidewall outlets, a ceiling outlet and two or more baseboard receptacles to provide connection for electroliers, piano lamps, heating or power devices. The ceiling and sidewall lights can be most conveniently controlled by a sidewall switch placed beside the door through which entry is most often made. There should be a spare baseboard receptacle to provide for the occasional use of fan, emergency radiator, cigar lighter, vacuum cleaner or floor polisher. It may be advisable in some cases to provide a wall switch which will control whatever piece of apparatus is used in connection with the baseboard receptacle. In the living room particularly, and in the lower hall and dining room, it is very convenient to have some arrangement for switching but a part of the lamps in the room so that the room can be lighted either dimly or brightly as desired. This might be accomplished either by two separate circuits, one controlling the bright lighting and and the other the dim lighting or else by three-way switches which enable but a part of the lights in the fixture to be turned on when so desired.

LOWER HALL. In the lower hall adequate switching facilities are of the greatest importance and mean much for the comfort of the home. Both the porch light and the hall lights should be controlled from beside the front door, so that the porch light may be thrown on as the door is opened and also so that on entering the house at night, the hall lights may be thrown on as the door is unlocked. The lights of both lower and upper halls should be equipped with three-way switches, in order that the lower hall may be illuminated from the head of the stairs and the upper hall may be illuminated from the foot of the stairs. This is a great convenience. A baseboard receptacle should be provided in the lower hall to connect vacuum cleaner, floor polisher, fan or emergency radiator.

PORCH. A porch light should be installed just outside the entrance door, so that it will illuminate the steps and the features of the caller without dazzling the eyes of the one standing within. Other lights may be desirable, also, but in any event have an outlet or two for the use of electric fans or table lamps. These outlets should not be placed very near the floor inasmuch as there is then some danger of getting water into them in case of a severe rain or in washing the porch.

RECEPTION ROOM. The illumination of a reception room must depend very largely on the character of the room itself. Baseboard receptacles should be provided to connect a decorative electrolier, and receptacles should be provided for connecting vacuum cleaner, floor polisher, emergency radiator and fan.

THE LIBRARY. In the illumination of a library soft light of harmonious tone is essential. Baseboard receptacles should be provided at several sides of the room to permit of the use of portable reading lamps without having long cords extending under foot or under the rugs. Receptacles should also be available for connecting vacumn cleaner, floor polish, emergency radiator, fan, cigar lighter and similar conveniences.

DINING ROOM. In the dining-room the illumination is most effective if provided from a central ceiling outlet so that a strong, mellow light will be furnished right over the table from a dome or shower fixture. This may be supplemented by sidewall fixtures, if the size of the room makes it advisable. The central lights should be controlled from a sidewall switch beside the pantry door, but it should not be necessary to walk around the door as you enter from the pantry to push the switch. Flush receptacles should be provided—one in the floor beneath the table and another beside the serving table, so that the use of chafing dish, coffee percolator, tea kettle, toaster, disk stove, griddle, waffle iron,

warming dish, emergency radiator, fan, electric flower decoration, miniature decorative lighting outfit, vacuum cleaner or floor polisher may be conveniently used. It is very convenient, also, to have the interior of the china closet illuminated with small low-volt Mazda lamps which may be operated by a separate transformer in such a way that the lights will turn on when the doors of the china closet are opened. In this way it is always possible for the maid to see exactly the location of the various dishes in the cabinet and by having things brightly illuminated within, there is much less danger of accidental breakage in taking dishes out or putting them back.

Kitchen. The number of lights which should be provided in the kitchen will depend entirely on the size of the room. A fixture in the center of the ceiling is usually of service to provide a general illumination, but if no auxiliary sidewall fixtures are installed it will be found that the maid usually stands in her own light at the stove or sink. Two sidewall brackets will correct this bad feature, and in a small kitchen will be ample in themselves. It is in the kitchen, of course, that electric service offers its most help ful applications, and the following appliances are available: electric range, water back attached to boiler, water urn, waffle iron, vegetable boiler, broiler, chafing dish, coffee percolator, tea pot, toaster, plate warmer, baking dish, water filter, outfit for beating eggs, grinding coffee or meat, turning ice cream freezer or dough mixer, vacuum cleaner, fan and silver polisher.

The Upper Hall. The lighting of the upper hall requires simply a soft, general illumination and will probably be provided by one or more sidewall fixtures. A turned-down lamp near the head of the stairs is a great convenience and safety, for it may be burned dim throughout the night, at practically no cost. A sidewall three-way switch should be provided so that the lower hall lights or the entire lower floor may be thrown on from the head of the stairs. A baseboard receptacle should be provided for connecting the vacuum cleaner and floor polisher.

Bedroom. Probably the most varied requirements of the house will be found in the bedroom, for at one time or another it combines the uses of nearly all the other rooms. If the room be large, a central ceiling fixture should be installed with two or more sidewall brackets so placed as to provide proper illumination for the dressing table, chiffonier, writing desk and beside the bed. Every room should be studied for the possible arrangements of furniture. There are usually two bed spaces to which the other articles of furniture must adjust themselves. If it is inconvenient or too expensive to provide enough sidewall fixtures to insure perfect illumination, baseboard receptacles should be so placed that portable lights on the desk or beside the bed will be available. In some cases the switches controlling the lights of the lower floor are installed inside the entrance door of the master's bedroom, where of course there will also be push buttons for the electric bells to the servants' quarters. This lighting switch is the most effective burglar protection and is especially desirable in suburban houses.

The Bathroom. The lighting of the bathroom should insure a strong light on the face from both sides of the mirror for convenience in shaving. This will probably afford all the general illumination desired. Care should be taken so that these light sources and the window are not on opposite sides of the bath tub or any fitting, so that there may be no strong shadows thrown upon the window shade. There should be several receptacles provided in the baseboard or wainscot, so that a small luminous radiator, a massage vibrator and a shaving mug may be constantly connected and with facilities for the occasional use of hot water urn, sterilizer, hair dryer, curling iron, hot water cup and fan.

Large Closets. The large closets for coats, linen, etc., and the lavatories, if any, should be provided with a lamp placed directly over the door in a horizontal position and controlled by a door switch. In the case of the lavatory this lamp may be supplemented by another lamp within the room which is not on the door switch circuit and which, of course, can be left burning when the door is closed. It is always desirable to have these lamps with a pull chain socket so in case the closet door is left open any length of time, as in airing the rooms, the light can be extinguished.

The Attic. The attic should be provided simply with general illumination so that it may be possible to examine the contents of trunks, etc., without too many black shadows.

Cellar. The cellar should be provided with sufficient light to make it bright and safe in every part. The important features, of course, will be the providing of proper illumination before the furnace, in the store room, and at the ice-box if it is located in the basement. The cellar lights should all be controlled from the head of the cellar stairs, and a small red lamp of about two candle-power should be wired in to burn as a beacon light and insure the cellar circuit being turned off when not in use. Auxiliary outlets in the cellar may be required over the work bench, but these will suggest themselves in each case. Electric motor-driven household refrigerating outfits are now practical for medium-sized and large houses. Motor-driven force pumps are also available where there is not city water and are far superior to the service of windmill, hydraulic ram or gas engine. In large houses, also, the vacum cleaning system will be most economical and convenient if a stationary plant is installed in the cellar and the house piped for cleaning service.

-URES AND REFLECTORS SUITABLE FOR RESIDENTIAL SERVICE.

The electric lamps at present available for practical use in residence lighting are all of the incandescent type. They are classified as: Carbon filament; Gem or metalized filament; Tantalum filament; "Mazda" or tungsten filament. The carbon filament lamp is the one most generally known and used, having been in service since the introduction of residential electric lighting. It has the lowest efficiency of any of the incandescents and consequently, costs the most for electric current. The carbon lamps consume from 4 watts per candle, in extreme cases, to a little less than 3 watts per candle.

The Gem, or metalized lamp ranks next in efficiency. This lamp is essentially the same as the carbon filament lamp except that the filament is treated to a metalizing process which permits its being burned at a higher temperature, thereby giving it a higher efficiency. This lamp is rated at present at about 2.5 watts per candle. Both the Gem and the carbon lamp are very rugged and are recommended for use where the lamps are subject to rough handling, as for example, hand-lamps in garages or stables.

The tantalum filament lamp is next in order, as regards efficiency, its rating being about 2 watts per candle. This

lamp was the first metallic filament lamp and would have met with wide popularity had not the tungsten filament lamp followed it into the market so closely.

The tungstten, and its later development, the so-called Mazda lamp, revolutionized lighting by raising the efficiency of incandescent lighting to 1.25 watts per candle, and even 1 watt per candle in certain cases; that is, a tungsten or Mazda lamp gives practically 3 times as much light as a carbon lamp which consumes the same amount of current. When this lamp was first introduced, the tungsten filament was extremely fragile so that the lamps were impractical for many classes of service. The latest type of Mazda lamp, however, with its drawn wire filament, is of such hardiness that no one need hesitate to install it except where the lamp is subject to actual abuse.

The standard Mazda lamps most installed for residential lighting are the 25-watt and 40-watt sizes. The list prices of these lamps are about respectively 70 cents and 75 cents with frosted or half frosted bulbs. The life is conservatively rated at 1,000 hours. With electric current at 10 cents, taken for convenience, per kilowatt hour, and assuming that the lamps burn 300 hours per year, the total cost for frosted or bowl frosted lamps and current would be, for the 25-watt lamp, 96 cents, and for 40-watt lamp, $1.42½ per year. Compare this with the cost of carbon lamps: if we take the highest efficiency (3 watts per candle) 50-watt carbon lamp, giving roughly, 4 less candlepower than the 25-watt Mazda lamp and 16 less candlepower, or half as much as the 40-watt Mazda lamp, we find that the cost of current alone, at 10 cents per kilowatt hour, is $1.50 for 300 hours' use. Even where 50-watt carbon lamps of the highest efficiency are furnished free by the lighting company and where Mazda lamps must be purchased at full list price, it is much cheaper to burn Mazda lamps for where the current costs 10 cents, or over, a 25-watt Mazda lamp will give 25 per cent more light for 64 per cent as great a total cost and a 40-watt Mazda lamp will give 100 per cent more light for 95 per cent as great a total cost.

However, price is not the only consideration. The higher efficiency Mazda lamp permits the use of art glass shades at a cost which is reasonable despite the great amount of light they absorb, while the color-true light of the Mazda lamp is not only more desirable, but easier on the eye than that of less efficient lamps.

Of fixtures, there is practically no end. Each year sees new styles, new finishes. One would say, off-hand, that selection of fixtures is wholly a matter of taste, but this is only partly true. A few principles of correct lighting should be remembered in the selection of fixtures, as well as the cardinal rules of good taste.

Ceiling fixtures in which the lamps hang at an angle should generally be avoided. This is because such fixtures do not hold the lamps in a position to secure the greatest practical efficiency from lamps and reflectors.

It will be seen that the light from an angle fixture is thrown largely against the sidewalls, and no matter what type of reflector is used, this waste of light continues. On the other hand, with the lamps hanging straight pendant, the light is distributed in useful directions and the reflectors, of course, add materially to the efficiency of the unit.

In the case of the so-called "indirect" lighting, practically all the light is thrown to the ceiling and thence distributed and diffused over the whole room. This system, while not so efficient as the direct lighting system, has many advantages and many advocates. The resultant illumination is practically shadowless and is particularly desirable where a soft effect and complete diffusion of light is desired.

Aside from the basic principle of having lamps pendant, it is usually advised against the so-called "combination" fixtures. It is well, perhaps, to have a combination gas and electric sidewall bracket in the kitchen, bathroom, upper hallway and living room for use in possible emergency, but the idea that such fixtures are necessary throughout the house is entirely erroneous. Combination fixtures, excepting sidewall brackets, are invariably make-shift designs. It is a practical impossibility to secure such fixtures of sufficient artistic merit to warrant their being installed in any home of refinement. They are a heritage of the "old days" when electric service, being new and in an almost experimental stage, was necessarily unreliable. Today electric service is even more reliable than gas. Combination fixtures are expensive and the extra gas piping necessary to connect them is expensive and this represents an unwarranted investment which the home builder may avoid entirely or divert to other and more practical uses.

In residential service, glassware is generally selected more for its artistic appearance than for any other reason. This is a partial mistake. Due consideration should be given to efficiency and to visual effect as well as to artistic merit.

The standard reflectors of efficiency are those such as the "Holophane," which are designed upon the principle of the optical prism and are acknowledged to be among the most efficient globes and reflectors available.

Of opal or translucent glass there are many makes of varying merit—mostly good. The products known under the trade name of Alba, Pheno, Luceo, Carraro, Lucido, etc., are all to be accepted as of high standard, as being efficient and as giving desirable distributions of light. Mere efficiency, however should not be the only, or even the chief reason for selecting glassware, except in such places as pantrys, back hallways, etc., where it is desirable to practice economy at the expense of artistic appearance.

Cut glass, ground glass and a wide variety of etched and colored globes and shades are generally inefficient, but there are many cases in which artistic effect outweighs all considerations of economy. The practical guides to follow in the matter of selection of glassware should be: first, the pleasing appearance of the glassware both lighted and when "cold," or unlighted, and also its fitness and harmonious effect in relation to the decorations of the room; and, second, the photometric curves of the glassware, which tell exactly what may be expected in the way of illuminating results.

The so-called "Tiffany" glass or Iris glass has much merit as a reflecting surface, and if the proper shapes are selected, very high efficiency can be secured with the maximum of artistic effect. These shades have a film of metalized glass on the inner surface which has high reflective power and great beauty of color.

Where leaded or art glass domes are used, it is well to use also an efficient clear glass reflector to re-direct the light rays downward. This same idea can be carried out in parlor, den or living room, by putting artistic silk shades

over highly efficient reflectors, thus securing the desirable combination of cosy attractiveness and practical economy.

Too much stress cannot be put upon the fact that over half the success of a lighting installation depends upon the selection of lamps and glassware. This is not generally appreciated, but when it is explained that, in commercial installations, such as stores and offices, illuminating engineers frequently effect a saving of 50 per cent in cost of electric current simply by changing the lamps and reflectors, the importance of this part of the equipment will be evident. The householder will not, of course, seek such economy at the expense of cosiness and attractive effect, but will look to his lamps and reflectors simply as a means of securing *sensible* economy.

HEATING APPLIANCES, POWER APPLIANCES AND FITTINGS FOR HOUSEHOLD USE.

While the cost of manufacture and distribution of electric current does not at the present time permit of its sale for household consumption at a rate sufficiently low to justify its exclusive use for heating or for all the family cooking, there are many applications of electric heat which are truly economical. For use in emergencies, the electric radiator is both practical and economical, and the small electric cooking devices which have become so popular in the last few years not only perform their functions with entire success from the culinary standpoint, but at an insignificant expense. Each one is a rational luxury even in the home where pennies must be counted.

The following table lists the standard heating and cooking devices which are widely used today in domestic service. The "cents per hour" column is computed at the rate of 10 cents per kilowatt hour merely for convenience in figuring. From the parallel equivalent in watts it is a simple matter to adjust the cost to any existing rate.

DOMESTIC HEATING DEVICES. WATTS CONSUMED AND COST OF OPERATION BASED ON 10 CENTS PER KW. HOUR.

	Watts.	Cents.
Broilers, 3 ht.	300 to 1200	3 to 12
Chafing dishes, 3 ht.	200 to 500	2 to 5
Cigar lighters	75	0.75
Coffee percolators for 6-in. stove.	100 to 440	1 to 4.4
Coil heaters	110 to 440	1.1 to 4.4
Corn popper	300	3
Curling-iron heaters	60	0.6
Double boilers, 6-in., 3 ht. stove..	100 to 440	1 to 4.4
Flatiron (domestic size) 3 lb....	275	2.75
Flatiron (domestic size) 4 lb....	350	3.5
Flatiron (domestic size) 5 lb....	400	4
Flatiron (domestic size) 6 lb....	475	4.75
Flatiron (domestic size) 7.5 lb...	540	5.4
Flatiron (domestic size) 9 lb....	610	6.1
Foot warmers	50 to 400	0.5 to 4
Frying kettles, 8-in. diameter....	825	8.25
Griddle cake cookers 9x12 in. 3 ht.	330 to 880	3.3 to 8.8
Griddle-cake cookers, 12x18 in. 3 ht.	500 to 1500	5 to 15
Heating pads	50	0.5
Instantaneous flow water heaters.	2000	20
Kitchenettes (complete), average.	1500	15
Nursery milk warmers	450	4.5
Ornamental stoves	250 to 500	2.5 to 5
Ovens	1200 to 1500	12 to 15

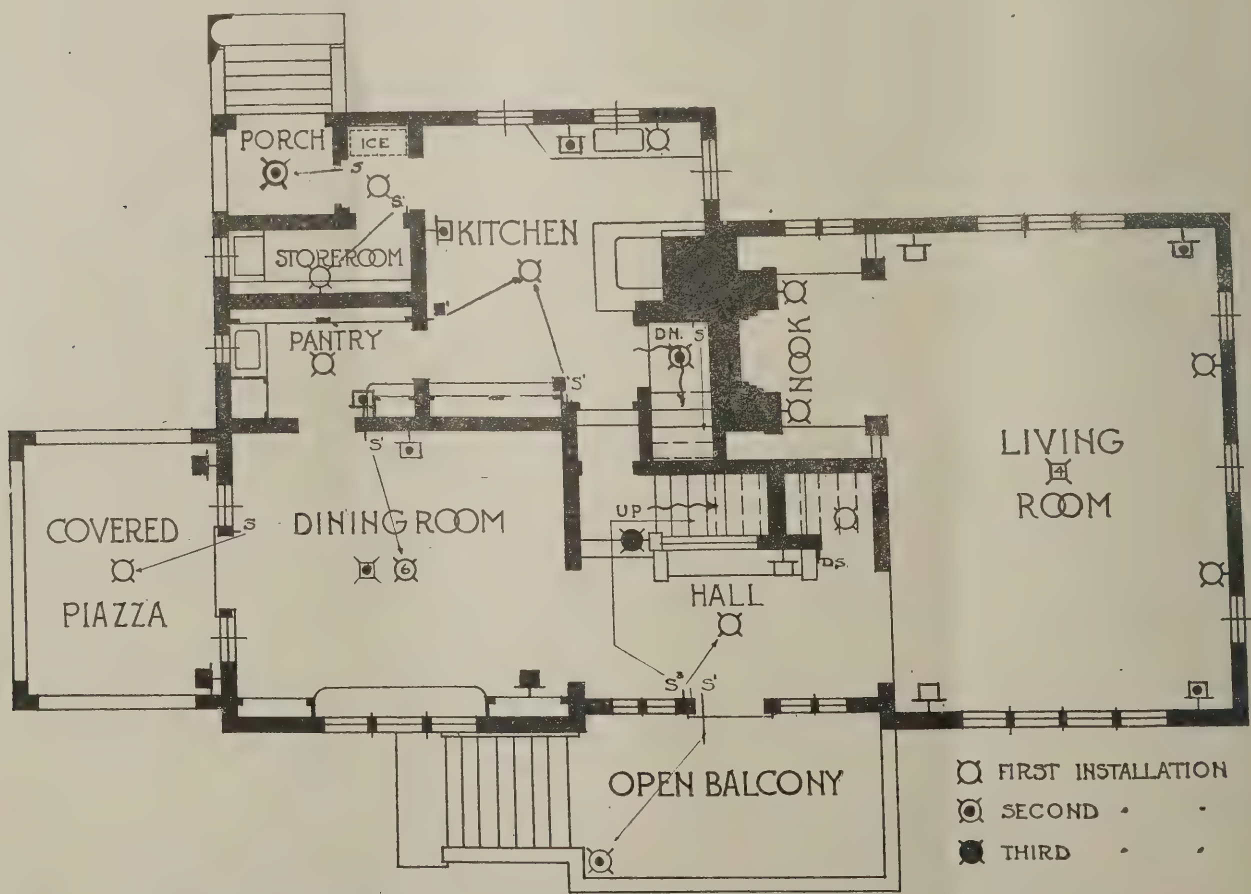


Fig. 1. Plan for First Floor of a Nine Room House Showing Electrical Layout.

Plate warmers	300	3
Radiators	700 to 6000	7 to 60
Ranges: 3 heats, 4 to 6 people	1000 to 4515	10 to 44
Ranges: 3 heats, 6 to 12 people	1100 to 5250	11 to 52
Ranges: 3 heats, 12 to 20 people	2000 to 7200	20 to 72
Shavings mugs	150 to	1.5
Stoves (plain), 4.5 in., 3 ht	50 to 220	0.5 to 2.2
Stoves (plain), 6 in., 3 ht	100 to 440	4.4
Stoves (plain), 7in., 3 ht	120 to 600	1.2 to 6
Stove (plain), 8 in., 3 ht	165 to 825	1.5 to 8.25
Stoves (plain), 10 in., 3 ht	275 to 1100	2.6 to 11
Stoves (plain), 12 in., 3 ht	325 to 1300	3.2 to 13
Stove, traveler's	200	2
Toasters, 9 in. by 12 in, 3 ht	330 to 880	3.2 to 8.8
Toasters, 12 in. by 18 in., 3 ht	500 to 1500	5 to 15
Urns, 1-gal., 3 ht	110 to 440	1 to 4.4
Urns, 2-gal., 3 ht	220 to 660	2.2 to 6.6
Urns, 3-gal., 3 ht	330 to 1320	2.6 to 13.2
Urns, 5-gal., 3 ht	400 to 1700	4 to 17
Waffle irons, 2 waffles	770	7.5
Waffle irons, 3 waffles	1150	11.5

ELECTRIC POWER APPLIANCES.

The domestic power appliances represent not alone improved mechanical methods, but in most cases a means of actually banishing some curse of household drudgery. The vacuum cleaner provides a release from the broom and backache that has preyed on womenkind since the first house was swept. But it betters the broom by removing the dirt instead of stirring it about. There is no dusting, no flying germs, no tuberculosis danger.

The floor polishing machine waxes and polishes the hardwood floors without the hours of rubbing and polishing that have always made it a long dreaded job.

The washing machine washes and wrings the clothes with less wear on the fabric than the board and hand method, and what was formerly a full day's work is done by the middle of the morning.

In short, these domestic power devices are a long step toward the solution of the vexatious servant problem. It makes womankind independent of the servant to an amazing degree and enables the young housekeeper to do her own work free from drudgery. And when the work is done electrically it is thorough and complete.

PLANNING THE WIRING.

The enjoyment and utilization of electric service in its fullest sense is, of course, largely dependent on the flexibility of the wiring system. The installation of extra outlets is of greatest importance if the household is to enjoy the benefits available. There are many cases where a lamp socket is the logical point for connecting the toaster, fan, or heating pad, but as a rule these appliances displace illumination, and this is inconvenient and the hanging cord is unsightly. Moreover, where a scarcity of outlets makes it necessary to carry wires across the floor, there is danger of their being stumbled over, when the fixture may be bent or pulled loose or the appliance injured. The sole object of these devices is to provide convenience and comfort and this object is lamentably defeated if their use is made awkward and inconvenient. This applies equally to the illumination.

This advocacy of auxiliary outlets, however, must not be allowed to cloud the fact that one of the prime virtues of the small electric household devices is the fact that they can be connected to and operated with full benefit from any handy lamp socket or any floor, wall or baseboard receptacle. For the larger apparatus, however, consuming over 500 watts, the ordinary lamp sockets should not be used, but separate wall receptacles employed in their stead, each controlled by a separate switch in the same room.

As is well known, electric wiring has certain definite capacity. If an installation is made upon the basis of the least amount of equipment possible, any appreciable additions to that equipment means overload upon the circuits. And this overload is generally dangerous. The sensible

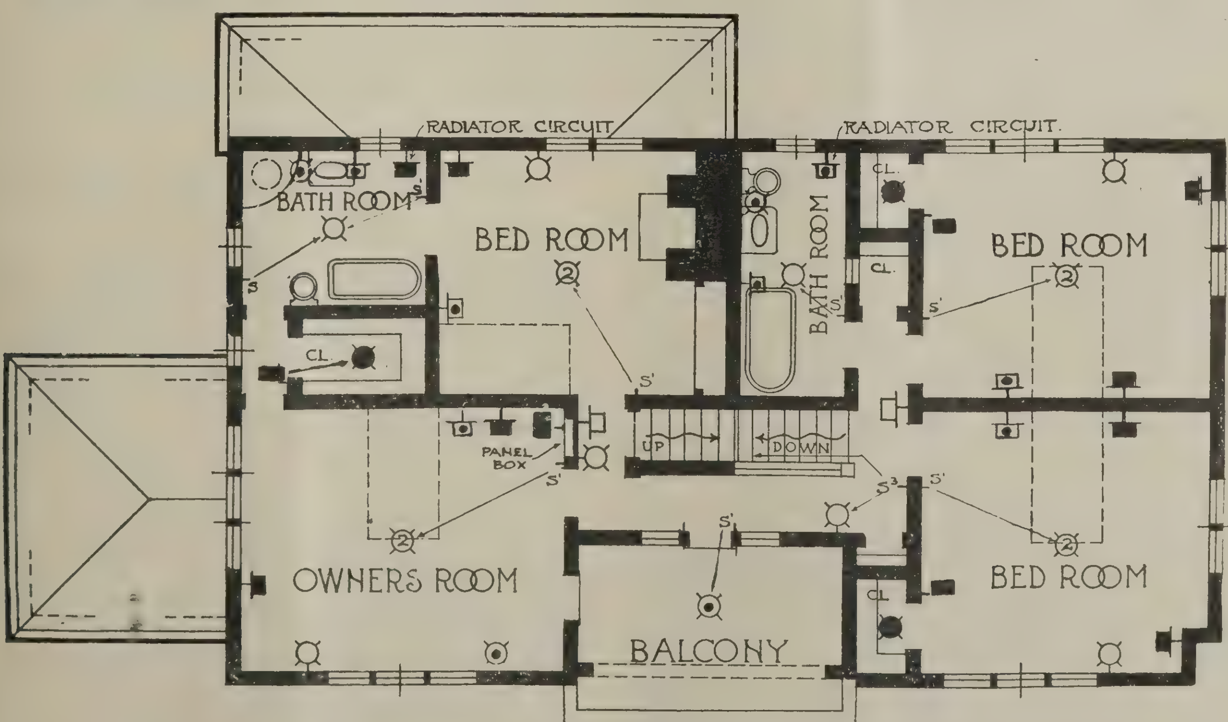


Fig. 2. Layout for Second Floor of House of Which Fig. 1 Shows the First Floor.

thing to do, therefore, is to provide ample capacity in the original installation and to plan this installation in such manner that the future expansion will be taken care of at the minimum cost.

In the plans shown in Figs. 4 and 5 the first and second floors of a moderate-priced home of nine rooms are shown and the necessary baths and storage space. In laying out this installation we have indicated three distinct plans or degrees of electrical equipment.

The first installation, indicated by the black symbols with white centers, represents the minimum equipment which could reasonably be installed, as follows:

HALL. Centre fixture with 3-way switch controlling lights in both upper and lower halls. Light in coat closet under stairs.

LIVING ROOM. Centre 4-light fixture, sidewall brackets in nook on the dark side of the room, and two baseboard receptacles for portable lamps, fans, etc.

DINING ROOM. Centre fixture over dining table with sidewall switch at pantry door.

PIAZZA. Centre light at ceiling with switch just inside dining room door.

PANTRY. Centre light.

KITCHEN. Centre light, sidewall bracket over sink, and ceiling light in front of ice box and storeroom.

UPPER HALL. Sidewall bracket at head of stairs and in passageway at foot of attic stairs. One baseboard receptacle for vacuum cleaner.

BEDROOMS. Two-light ceiling fixtures and one sidewall bracket in each room. In owner's room, ceiling fixture controlled by sidewall switch; in other rooms, by pull chain sockets.

BATHROOM:. Ceiling light controlled by sidewall switch. This will give the basis of the installation—light in every room, a single baseboard receptacle for the vacuum cleaner in both upper and lower halls, and two receptacles for fan and portable lamps in the living room. Such an equipment is adequate for the bare *necessities*, but no one, made to provide increased electrical comforts, should will-knowing the luxury, labor-saving and convenience of electric service, or realizing the rapid strides that are being ingly plan to limit the installation to such primitive scope.

The next step indicated by the symbols with dots in center consist of additions in the form of added lights, baseboard outlets and more convenient switches. A back porch light and one in the cellar stairway, and upper balcony, are worth all they cost; while the addition of sidewall switches in the bedrooms and a floor receptacle in the dining room are so important as to almost merit being included in the first plan. The baseboard receptacles are fairly well scattered. Those in the bedrooms are for reading lamp, heating pad and fan—utilities which have everyday service. Those in the dining room, pantry and bath are less obviously necessary only to the person who has not enjoyed complete electric service; to the man of experience they are a daily convenience.

The final step in the installation includes receptacles on the covered piazza (where the family probably dines in summer), an extra light in the lower hall, and lights with automatic door switches in the bedroom closets. Extra baseboard receptacles are also provided where most convenient.

The reader must not understand that these various steps in the development of an installation are all to be accomplished successively as outlined. The purpose is to show the most complete practical equipment, and, by process of elimination, indicate what wiring or equipment may be omitted. Thus, the wiring contractor, when he understands the ultimate purpose can allow intelligently for the development and can so arrange his circuits as to provide ample capacity for future needs.

For example, the "master switch" in the owner's bedroom is, as stated before, the best burglar protection because it enables the owner to light every lamp on the ground floor from a single switch located at the head of his bed. This great convenience, however, cannot be added to the equipment, except at great expense, unless the wireman knows in advance that it will be wanted. To properly and economically run his circuits for such a switch would require the panel box, or center of the distribution system, to be located about as indicated on the plan, in the passageway beside the owner's bedroom. Again, the sidewall switches in the bedrooms may prove to be practically impossible, as an added convenience, if the lights in these rooms are taken off a circuit which is not planned with a view to the switches.

It will be seen that we have not indicated the actual circuits, but only the locations of outlets and switches. This is because the wiring plans would be very confusing and not at all helpful in showing the desirable utilitarian features involved.

In conclusion, we can only repeat our previous suggestion: Plan wiring upon a generous, even an extravagant, basis. Then eliminate those features which may not seem immediately desirable, bearing in mind, however, that they will be added ultimately. If wiring is installed upon this basis it means that the householder will never lack for electrical convenience; it means that the electrical contractor will never lack for customers desiring additional equipment and appliances; it means that the central station will never lack for a healthy growth of the business. Thus will all three interests be best served and most thoroughly satisfied.

Discussion on Averaging Bristol Charts with a Planimeter.

(*Contributed Exclusively* to SOUTHERN ELECTRICIAN.)

BY HARVEY S. PARDEE.

In the February issue of SOUTHERN ELECTRICIAN there appeared an article describing a method for averaging charts of the Bristol type by means of a planimeter. As this method in principle is a very common one and widely used it seems desirable to call attention to the fact that it contains dangerous fundamental errors which render its use worthless if not actually deceptive in a majority of cases. For instance in the chart shown the value given as 205 K. W. should be 167 K. W. or an error of about 23 per cent. Indeed the eye is better than the method in this case, for it is plain to see that the value 205 is excessive. Even more grotesque results are obtained with charts where the principal load is on but a part of the day. That is a 24-hour average of a 12 hour load and 12 hour no-load chart, or semi-circular, would be 41 per cent and a chart with full load shown for 8 hours only would be subject to an error of 73 per cent approximately if measured by the planimeter method.

The principal error is due to the fact that the planimeter method gives the root-mean-square value instead of the average value. The two values coincide for a complete circle but the former is always excessive for an irregular area. The error is very easy to fall into because the derivation of the result seems mathematically sound but the result obtained is not the one we are looking for. In preparing the table given in the article the computer actually computed mechanically the areas of the various circles which work had more properly and easily been done with a scale and a slide rule according to the familiar formula. Area $= \pi R^2$.

These circles may be said to be the averages of the irregular equivalent areas and obviously the area is proportional to the square of the constant or average radius. In application the formula is reversed and the value of the radius is computed or taken from the table, which is the same thing, the result being the square root of the average square values.

The following proof gives the mathematical considerations of the problem: Consider any elementary sector of the figure $r = f(\Theta)$ and so thin that its sides are sensibly parallel and form a triangle with altitude (r) and base $(r\,d\,\Theta)$. Its area is then, $A = r/2\ (rd\Theta)$. The area of the whole figure then is

$$A = \int_0^{2\pi} (r^2 d\theta)\ /2 \text{ ------------}(1)$$

and the result of the planimeter method is found by taking the radius of a circle of area equivalent to A.

That is,

$$R = \sqrt{\int_0^{2\pi} (r^2 d\theta)\ /2\pi} \text{ -----------}(2)$$

That (2) is the same as the root-mean-square value may be shown as follows: The average square is found by considering the thin sector a rectangle. Square its length and multiply by the base. Add these products for the whole figure and divide by the total base. The square root of the result is the square root of the average square.

$$R(\text{eff}) = \sqrt{\int_0^{2\pi} [(r^2(rd\theta)]\ /2\pi r} \text{ ----------}(3)$$

This is obviously identical with (2). The true average radius however, is found by considering the sectors as rectangles multiplying by the first power of the length adding the products and dividing by the total base.

Thus

$$R(\text{ave}) = \int_0^{2\pi} r(rd\theta)/2\pi r = \int_0^{2\pi} rd\theta/2\pi \text{ --}(4)$$

Clearly the true value (4) is different from the value (2) of the planimeter method.

A smaller error is due to the fact that the co-ordinates corresponding to radii of a polar diagram are not straight but curved lines that do not necessarily intersect the center even. A more important error that should be mentioned, which however, does not apply to the chart illustrated is due to the scale not being always uniform. Some scales are so crowded at the extremities that the results of the planimeter method would be worthless on that score alone.

As mentioned in the article, there is an instrument on the market designed for correctly averaging these charts providing the scale divisions are uniform, but lacking this instrument, the most important adjuncts are the adding machine for adding values from the curve and a slide rule. 96 ordinates from chart 364 give a total of 16,085 or an average of 167 K. W. approximately.

Finally it should be noted that the planimeter method gives the same result for a given area independent of the shape of the area or its position on the chart. While the average radius is a maximum for a circle and diminishes for any distortion from this shape.

Atlanta Section of A. I. E. E. Holds Interesting Meeting.

On the evening of March 12th, the Atlanta Section of the American Institute of Electrical Engineers held an interesting meeting, when papers were read on the following subjects: "Proposed Recommendations to County and Municipal Authorities Governing Transmission Line Construction," by A. M. Schoen, Chief Engineer Southeastern Underwriters' Association; "Incandescent Lighting from Three-Phase Systems," by J. N. Eley, Consulting Engineer of Atlanta. These papers were carefully prepared and the spirited discussion showed their particular interest to all present.

The meetings of the Atlanta section, of which Mr. A. M. Schoen is chairman, have been carefully planned and for those meetings to come, there will be presented complete and authoritative discussions of interest to electrical men generally, and arrangements are being made whereby those who are not members of the association can attend and take part in the work. For early meetings the subject of synchronous motors for raising power factor and the induction motor with its tendency to lower the power factor will be taken up for consideration and discussion.

In view of the fact that Mr. Schoen's paper is on a subject which effects a large number of towns and cities throughout the country where hydro-electric companies are pushing their high tension lines, and further will be one of the subjects to be proposed by him and discussed at the electrical committee meeting of the Underwriters' National Electrical Association, to be held in Boston, March 27th, we give the paper in some detail as follows:

Recent extensions and consolidations of power companies and the extensive development of hydro-electric properties in the South has made it imperative that both City and County authorities take thought as to what precautions shall be required of corporations where use is made by them of the public highways for their overhead lines. Most of the transmission lines are in connection with two or more plants operated in parallel and are erected with a view to serving large sections of the country. In order to find proper market, very considerable distances must be traversed and economy as well as efficiency demands operation at excessively high voltages. The two most popular differences of potential in this field have been 66,000 and 110,000 volts. In nearly every instance the power companies themselves have very wisely elected to avoid the public highways with their extra high tension lines and by purchasing and paying good money for private rights-of-way, minimize their liability to damage suits as the result of accidents to passersby in the vicinity of their lines, and it is difficult to understand how the same

engineer who would not consider making use of the country highways, even though their use were freely proffered, would be quite satisfied to carry his 66,000 or 110,000 volt lines overhead through the streets of a city, even though these streets were among the least thickly inhabited. The only explanation is rank commercialism, and the city that allows this to be done is generally either caught napping or has been badly advised. Unquestionably these high voltage lines can be so designed and erected as to reduce the initial danger to a practically negligible quantity, but the factor of safety that should be rigidly maintained is not to be relied upon with the large human element entering thereinto—commercialism will play its part here as elsewhere. Reasoning from the viewpoint of convenience and a slight increase in efficiency, one can readily see why the company prefers to continue its high voltage lines into the vicinity of the center of the town if the distributing plant is already located there, as this may also tend toward an economy in operation, but it is a question of very considerable doubt whether this can compensate for the dangers to both life and property that may ensue from taking advantage of it. Even though every precaution be taken in the way of good mechanical construction and high dielectric strength, absolute immunity from breakage and leakage are impossible, and the likelihood of these increases with the life of the system. At the time of construction, having in mind possible accidents and the nature of the current used, every detail is carefully worked out and followed, but here, as elsewhere, familiarity breeds contempt, or at least carelessness, and as time passes, rotting poles, rusting metal, and nicked or cracked insulators are not so closely watched, wires of other systems are strung in proximity as convenience, economy or expediency may dictate, and the possibilities of trouble steadily increase. On the other hand, if the city grows along the route taken by this pole line and it becomes incumbent upon the telephone company or the fire alarm department to extend its lines paralleling those of the high voltage system, the service is liable to be seriously affected, due to inductance and electro-static conditions. Another feature to be considered where the original line voltage enters the city, is that there is no immediate control possible between the sub-station and the power plant, which may be one hundred miles or more away, and in case of accident, even though the breakers at the power plant go out, they would probably be again thrown in until the operator should become convinced of serious trouble on the lines.

Some two years ago, following a request of the Commissioners of Fulton County, Georgia, the writer in conjunction with Messrs. H. P. Wood, J. N. Eley and F. N. Miles, agreed to formulate a set of specifications to regulate the building of high tension lines through Fulton County, and the result of the work of this committee, after being threshed out with the representatives of the various electrical interests in the State directly affected, is embodied in the following, which in the Speaker's opinion forms suitable specifications for general recommendation to County and State Officers:

SPECIFICATIONS.

For municipal lines I would recommend either that a sub-station be erected outside of the city limits and a difference of potential not exceeding 6,600 volts allowed between overhead wires, or else if the extra high tension lines must be brought into the city, they be brought in underground. Where the overhead lines are used for voltages in the neighborhood of 6,600, I would recommend that the following specifications under general rules Nos. 1, 2, 3, 4, 5, 6, 7, 8, and 9, be followed:

GENERAL RULES.

1. The pole line shall be confined to one side of the highway.

2. Where the highway is used, all power lines regardless of system or ownership shall be confined to the same side of the highway.

3. The lowest wire shall be at least thirty (30) feet above the ground at the lowest point of the system.

4. Lines shall be constructed with a factor of safety of two with the weather at zero degrees, the line covered with sleet to a depth of one-half inch and the wind velocity of seventy miles per hour.

The factor of safety for poles shall be:

Steel	3
Reinforced concrete	4
Completely creosoted wood	5
Other wood	6

The poles at the terminals of the portion of the high tension line covered by these specifications shall be of such strength as not to break under maximum load conditions if any or all of the conductors in the spans outside of this portion should break.

5. Signaling systems or other systems carrying a normally innocuous current shall not be strung on the same side of the highway with power lines.

6. Where necessary to cross signaling systems or other wires carrying innocuous or low voltage current, the construction shall be as follows:

A.—Short span construction; the total span length of the top system being less than the difference in height between the nearest wires of the two systems.

B.—The high potential line shall be so strongly constructed with respect to poles, cross-arms, insulators, wires with other fixtures, that the liability of a high potential wire coming in contact with a telephone wire is made negligibly small.

7. At angles or corners, unless tower construction, extra heavy poles shall be used with double cross arm construction, also suitable bracing and suitable angle irons properly grounded and having sufficient mechanical strength and carrying capacity to hold up any wire coming against them. Such poles shall be substantially set and guyed and guy wires shall have strain insulators at two points—one near the pole and the other not less than ten feet above the ground.

8. Minimum separation between the high potential lines and any other lines, meaning thereby the bottom wire of top fleet and the top wire of bottom fleet, shall not be less than ten feet.

9. The insulator pins shall be of steel or any other metal having sufficient mechanical strength and durability wherever the voltage is in excess of thirty-three hundred (3300).

Extra High Potential Wires. (*Over* 11,000 *Volts*).

Cross arms shall be of steel, or else equipped on the lower side with ground plate or metal strip of suitable mechanical strength and carrying capacity so arranged that any wire falling on the cross arm will, upon burning through, be immediately dead grounded.

If wires are carried on suspended insulators below the cross arm, a grounded arm of suitable strength and carrying capacity shall be arranged to catch the wires in event of their breaking away from their supports.

The grounded wire on the poles shall be protected to a distance of at least ten (10) feet above the ground to prevent any possibility of danger to those on the highway.

Recommendation.

Except where necessary to cross the public highway, companies erecting extra high potential lines should be confined to their private right-of-way.

DISCUSSION OF MR. SCHOEN'S PAPER.

The discussion of Mr. Schoen's paper brought out interesting features in connection with the subject, comments and suggestions being added by F. W. Hadley, Electrical Engineers with the Georgia Power Co.; W. R. Collier, Contract Agent for the Georgia Railway & Electric Co.; H. E. Bussey, Resident Engineer of the General Electric Co.; E. P. Peck, Assistant Electrical Engineer of the Georgia Railway & Electric Co.; Mr. H. P. Wood, Professor of Electrical Engineering at the Georgia School of Technology; H. M. Keys, Engineer with the Southern Bell T. & T. Co.; J. N. Eley, Consulting Engineer; H. E. Burdett, Southeastern Underwriters' Association. The discussion took up, principally, the features in limiting the voltage on all lines except where private right-of-ways and underground systems were used. Mr. Schoen and Mr. Burdett were of the opinion that the voltages should be limited to 11,000 volts and preferably 6,600 volts in order that the danger of accidental fires and deaths from transmission lines be kept at a minimum. Mr. E. P. Peck, supported the opinion that 6,600 volts would produce instant death, or would completely destroy any low voltage apparatus which it happened to come in contact with and that larger amounts of power, say 10,000 K. W., would require so many lines of 6,600 or 11,000 volts from point of economy that the danger from these lines would be much greater than from a properly built line of 66,000 volts. He maintained that electrical transmission is an industry of modern civilization, and that it cannot be dispensed with any more than can locomotives or automobiles. He agreed that high tension systems should be guarded as much as possible, but held that in his opinion this could not be done by keeping the voltage at 6,600. In discussing this matter, Mr. Bussey stated that the large number of heavy conductors necessary for the transmission at 11,000 volts, of large quantities of power, would cause much greater chances of breakage of lines, poles and conductors, and thus increase the risk at 6,600 volts transmission as compared with higher voltages. Mr. Schoen met these arguments as follows:

He stated it was quite true that trains and automobiles, though dangerous, were in common use, but the train is confined to its own right of way and both trains and automobiles upon entering cities are subject to speed regulations. As to construction, while theoretically every precaution would be taken in the erection of these lines and later in their maintenance, he added that some of the gentlemen present, as well as himself, could quote instances of recent occurrence in the field when the practical results showed far from the perfection we could be led to expect.

Mr. Schoen here quoted instances of broken high tension lines, heavily charged areas in the vicinity of a ground having to discharge to other overhead lines through a lightning arrester, ground wires highly charged and paralleling telephone wires, due to electro-static and inductive effects. Attention was also called to the fact that the enforcement of proper maintenance through municipal officers under a political system, would be problematical to say the least.

The question of interference with signalling and telephone lines was discussed, but it was not shown that the static disturbances from the high voltage lines were more serious than the magnetic disturbances from the medium voltage lines. At the close of the discussion Prof. Wood suggested that Mr. Schoen's paper be sent to the A. I. E. E. headquarters for incorporation in the proceedings, suggesting that material be added to take care of high tension lines, crossing of railway tracks, highways, other transmission lines and low voltage systems.

Mr. J. N. Eley's paper on "Incandescent Lighting for Three-Phase Systems," was suggested from the apparent confusion in the minds of electrical contractors in regard to the electrical relations in three-phase systems where such systems are used for lighting and power purposes. Mr. Eley pointed out the fact that the underwriters' rules did not cover the three-phase, three-wire lighting circuits as regards fuse protection, that is, no definition is given of the proper cutout to use, keeping the amperes in each leg at the required amount.

In view of the fact that Mr. Eley was unable, through lack of time, to cover in his paper all the points desired. he delivered his remarks extemporaneously for the most part. He was not able to present data which he had desired in order to show up certain comparisons between the Edison three-wire system and the 3-phase system, so that this part of the talk is being prepared and will appear in the next issue of Southern Electrician.

DISCUSSION OF MR. ELEY'S PAPER.

The discussion of Mr. Eley's remarks on the subject of three-phase systems was participated in by Messrs. Schoen, Tupper, Bussey, Wood, Davenport and Peck. Various technical and practical points were brought out and the general opinion expressed that the ruling in regard to fusing three-phase circuits should be interpreted to mean that a branch circuit should be fused with a six ampere fuse and the load on the circuit kept within the capacity of the fuses.

Mr. Bussey stated that through his experience with mill lighting propositions, he had never had a case come up where it was necessary to resort to three-phase lighting as the lighting load of the mill was usually a small proportion of the total load. On this account the unbalancing was a negligible quantity.

Prof. H. P. Wood advanced the opinion that there was an equalizing action, in case of unbalancing due to lighting on a three-phase system, brought about by the induction motors. He stated that with a two-phase motor, the phase receiving the higher voltage represents the motor action, while the phase receiving the lower voltage represents a generator action, thus tending to maintain a balanced condition. The conditions referred to in a two-phase motor he stated also applied to three-phase. He thus pointed out that the main burden of overbalance was thrown on the mill producing it, and not on the company supplying the energy.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

A New Department.

With this issue of SOUTHERN ELECTRICIAN, we inaugurate a new department to be known by the above title, "New Business Methods and Results." It will be our object to discuss in this department matters connected with the commercial side of the central station business and that of the electrical dealer and contractor, giving the widest possible range to the topics. We intend each month to take up some particular phase of the new business problem, outlining the subject editorially and asking for comment or discussion from all interested. We will also gladly receive suggestions for future topics, or the details of how you have solved some commercial problem. If you have any unsolved problems, campaigns about to start or under way and would like to have the experience of others on certain questions answered, state your case, or send in your question, and we will present the same through these columns. A list of topics to be treated and the order in which they come will be published in an early issue.

It is our purpose to make this section of value to every central station jobber, electrical dealer and contractor, and we can only do so through your co-operation. We trust that no one will feel so big as to be above giving us the details of his campaign or other proposition nor so small as to feel that his comments are not of value. In short we desire to conduct this section for the benefit of every one who has any interest, great or small, in securing new business from the electrical industries. The editor will be glad to receive personal letters from those interested in the work of this department, making criticisms or offering suggestions.

This month we consider the mutual relationship between the manufacturer of current consuming devices, the electrical dealer and contractor and the central station. It is a subject full of interest, and open to many different opinions. We trust that you will be free to comment upon the material offered. Address correspondence to Editor New Business Section.

Our Views on the Manufacturer, Electrical Dealer and Contractor and the Central Station.

The rapid growth of the electrical industry has brought about certain peculiar inherent problems, among which is the mutual relationship of manufacturers, electric dealers and contractors and the electric power and lighting companies. An editorial in the December number of this paper suggested some pertinent thoughts in this connection, which we will enlarge upon in what follows. That closer relationship and more co-operation is needed, is evident. The factors entering into the growth of the industry are such that all are affected, for each has his placce to fill and it is useless and detrimental to maintain an antagonistic or indifferent policy and thus retard development which if unhindered would benefit all the parties concerned.

Looking at the question first from the point of time, we find that in the past, the most interested parties have been the central station, the electrical dealer and contractor. Between these the general attitude was that of antagonism. There was no co-operation nor any effort to promote it, the central station in most cases doing wiring at cost, and in many cases forcing the contractor off the field entirely. On the other hand the contractor, bitterly resenting what he considered as an encroachment on his rights, lost no opportunity of getting back at the lighting company. This state of affairs was not, however, all the fault of the central station. In the early days of the industry, before there were any regulations governing the installation of wiring or understanding as to prices, there were a good many contractors whose work was not up to the standard, and whose prices to customers of the central station were prohibitive. This naturally retarded the extension of the lighting companies' business, so that in such cases they were compelled to take a hand themselves in order to protect their customers. While this has been a common excuse in the past, we do not believe there are many cases where it would be considered as sufficient today.

At the present date, we find conditions either changed or fast changing. Certain branches of the industry are coming to be recognized as belonging to the central station, others to the electrical dealer, others to the contractor, with still others in a measure to all three. Many things have come up regarding which we may hold widely varying opinions, but which are evidently here to stay, and in times to come will no doubt prove to have been best. We find that lamps to a large extent are distributed by the lighting companies, while the contractor is regaining much of the wiring work. We also find the manufacturer entering as an important factor from the standpoint of jobber, local dealer and central station, and all are beginning to realize that co-operation is after all, the best policy. Looking towards the future, the development of a system is plainly evident, for each of the parties concerned has his proper field of operation, and in the final analysis, each will have to do the part for which he is best fitted. As we see it therefore each is studying the conditions, carefully observing the trend of events, and getting into line.

Considering the interests of the parties concerned and the trend of electrical affairs, it is plain that the central station is bound to dominate in its field and its policies to control the situation. The position it holds as the manufacturer of the current and the magnitude of the interests involved, combine to render this the case, for in justice to itself, it is necessary for the central station to take a keen interest in all branches of the industry which affect its relations with the customer. This, however, is no excuse for a public utility company controlling light and power to assume an arbitrary attitude and to abuse their influence in matters affecting the public. We emphasize the fact that the control of electrical energy carries with it no privilege to dictate but does carry the obligation to serve and protect its clients, the public.

The manufacturer of lamps, and other current consuming devices is in a rather independent position. He is not directly interested in the disagreement going on between the other parties, for his desire is to place his goods on the market. It is therefore a case of dealing with the one that can handle them to the best advantage. Under present conditions the manufacturer generally favors the central station in regard to smaller current consuming devices as against the dealer because he believes that the former is better situated to handle a sufficient stock, has a better opportunity to push his product, and will have more interest in keeping it in good repair. Unquestionably he should, however, in every case consider general conditions and deal on an equality basis, not aiding or look-

ing with indifference upon a campaign which will be detrimental to either, one wholesale price to all and one retail price to the consumer.

The electrical dealer and contractor are the ones between the mill wheels, due partly to their own fault. With free lamp renewals, the profit cut off electrical appliances and wiring done at cost, they are often actually driven out of business. Yet there is a place that they only can fill, and should not be forced out of it. Any central station that does so, is ruining the prospects for the advancement of its own business.

Besides these four there is another interested party, the customer. New business managers state that from personal experience in the majority of cases the customer favors dealing with the central station in purchase of lamps and appliances. The reasons for this are evident. Prior business relationship has a great effect. The central station can and if proper relations exist, does do more for the customer in the way of service connected with the sale, free trials, deferred payments, repairs, etc., than the local dealer has done in the past and can afford to do. The customer feels that the transaction is not completed with the purchase of the article, but that the central station has an interest in keeping it in repair, as indeed it rightly should. Whether this is logical or not, it is a fact, and the customer has been systematically encouraged in such belief, until now it is a generally accepted conclusion.

Briefly then it is our opinion that the proper solution of all relationship differences will come down to finally this: The central station should sell electric service and promote the use of current. Whether it sells appliances or not, it should display and educate the public in the use of them, giving the customers the benefit of their advice and experience, to the end that they may be enabled to make an intelligent selection. Furthermore to preserve an impartial friendship towards and a lively co-operation with all reputable electrical dealers and contractors, supervising their work sufficiently to insure the customer a good job at a reasonable price.

The particular field for the contractor is the wiring of buildings and installing of motors, and electrical machinery, and that of the electrical dealer the handling of electrical supplies and appliances, co-operating with the public service companies in extending the use of electrical energy. In many localities these fields can be covered by one firm and when possible it is good policy.

The manufacturer should make a reliable article and stand back of it, no matter who markets it. He should use no partiality between the central station and the electrical dealer, but should stand back of both, and discourage the cutting of prices.

Taking up the branches of the electrical industry which have a place in this discussion we naturally think first of wiring. This is the rightful field of the contractor. While it is true that some central stations have been forced into it, yet there are some that have crowded into it, where there was no occasion or excuse for doing so. It is better policy for the central station to keep out of the wiring business, simply supervising the work of the contractors as far as may be desirable in the interest of the customer. Apart from the bad effect of forcing the contractor out of business, and thus depriving themselves of a valuable business getter, the central station is burdened with large responsibility for the upkeep of equipment, as the customer will expect the company to do much more for nothing in case of trouble with the wiring than they would of a contractor. Furthermore, the company that maintains a wiring department is always asked to do numerous small jobs gratis, which otherwise would not be expected. When we consider the overhead expense of the department, the room occupied, the supervision necessary, estimates to be given, the expense of carrying the stock, in the majority of cases it does not pay to do wiring at all.

When considering lamps the case is different, for the central station is the logical distributor. Before the standardization of lamps, the customer bought them anywhere, possibly saving a cent or two by patronizing the nearest bargain counter. The result was, of course, that he purchased many which were worthless, to say nothing of poor voltage selection, for most customers do not know the exact voltage on their lines. In a large system the voltage varies from point to point, and there is no one able to specify just the lamp that should be used in a given locality except the central station. Furthermore, buying in large quantities, they are assured of lowest prices on such quantity better quality, and higher uniformity of product than could be obtained by any other dealer buying in smaller quantities. With the policy of free lamp renewals, now common to the majority of public service corporations, all sockets will be filled with lamps, which would not be the case if the customer bought his own lamps. The free renewal carbon lamp is here to stay, and this being the case places the central station in command of lamp supply and distribution.

Exactly the same arguments we believe apply to the tungsten lamps. Some companies sell these at about cost while some sell them at a price equal to the difference in price between them and the carbon filament, at which prices the local dealer cannot compete. The same arguments applyed in the case of the carbon lamps, will apply possibly not with equal force, in regard to selection since the new lamps have been standardized almost from the first, with resulting better quality and uniformity. All others however, do hold.

In regard to appliances, here again the central station in many cases may be the logical, although not the exclusive distributor. A few companies have gone to the other extreme, and sell no appliances at all, simply keeping them on display, but referring the prospective buyers to the electrical dealers. The lighting company has however a number of advantages in putting them out, principally because of closer business relations with the consumer, and because of the mental attitude which exists or should exist towards the company on the part of the customer, as mentioned above. Nevertheless, the electrical dealer should sell appliances and should be encouraged to do so. The principal question that comes up regarding the sale is whether or not the price should be cut, and how much.

The sentiment on this point appears to be pretty well divided among central stations. Out of 15 answers to a question of this character in the Question Box of the N. E. L. A., there were six who favored selling at cost or nearly so, eight who favored selling at a profit, or at the regular price, and one who gave arguments on both sides. Quoting directly from the answers, the reasons given for cutting the price were as follows: "Increased sales of current—keeping in close touch with customer—customers will come in for repairs—appliances are pushed

only by the central station, hence should be sold at cost plus a small profit—quite an advantage—increases current sales for lighting—good policy." The arguments on the other side were: "No reason for it—discourages contractors from handling—already well enough advertised—incurs resentment of contractors—interferes with handling by others—reasonable profit does not discourage sales—fair purchase price enhances value to customer—should not undersell contractor—cutting never any benefit—poor policy—no trouble in selling at full price, even against department store competition—keep in line with contractors."

Neglecting such general statements as "good policy" and "poor policy" which are not specific, we can reduce these statements to their lowest terms very easily. Those who favor a cut price claim increased sales, and consequent increased current consumption, which their opponents flatly deny, claiming that the apparatus is sufficiently advertised, and that a man does not object paying a fair profit for something he wants and will even place more value on it because it is rather expensive. The strongest point made by those who stand pat on the price, bears on the relation of the company to the contractor, to which the others have no reply.

In considering these replies, it is to be remembered that even with the price to the central station and to the contractor on a par, the former will get nearly all of the business, so that there is but little to be gained by cutting the price for the purpose of drawing his trade, and a good many reasons why he should not do so. As to the arguments that more appliances will be sold at cost than at a profit, I will quote an example given some time ago in one of our contemporaries. A central station maintaining an appliance department, had the following record for six months selling nearly at cost:

Appliances sold	214
Total K. W.	77
Profit on sales	$164.63
Cost of department	636.72
Cost of appliance business per K. W.	6.12

The last figure given caused the new manager of the department to become interested. He knew that the cost of obtaining new business per K. W. should be around $2.00. He made a change and began to sell at a profit. For a subsequent six months he made the following report:

Appliances sold	228
Total K. W.	106
Cost of department	$374.80
Profit on appliances	386.43
Net profit	11.63
Cost of business secured	nothing

Quoting from his story he says, "There was no self-deception. No talk of the advertising value, or low selling to introduce or to increase the revenue. The department was made to stand on its own merit. There is no more logic in selling appliances at a loss than for a coal merchant to give away stoves becacuse they burn coal." This example we believe a good one and carries with it a moral for the central station, sell all appliances if handled at all the full retail price.

Finally, price cutting is unfair to the manufacturer. He cannot always prevent it even though he resents it. Its tendency is to destroy or cripple the hearty co-operation which the manufacturer would otherwise give to the central station and the electrical dealer and it has also a tendency to make the manufacturer cheapen his product to agree with the reduced price which can only result in dissatisfaction and prove a losing game all around. A. G. Rakestraw.

Our Readers' Views on Trade Relationship Between the Manufacturer of Current Consuming Devices, the Electrical Dealer and Contractor and the Central Station.

From the Standpoint of the Central Station.

Norman B. Hickox, Manager New Business Dept., Muskogee Gas and Electric Co., Muskogee, Okla., on Apparatus the Central Station Should Not Handle and Co-operation With Contractors in Regard to New Business.

Every city presents a somewhat different problem in our business, so far as the relationship between the central station and local contractor is concerned. Also many different and complex situations are presented in the relation between the contractor, the central stations and the manufacturer. Since I am asked to write regarding my own experience from the central station standpoint, and to advise what, in my mind, is the proper relation for the central station to maintain, it will be necessary for me to inject somewhat of the personal element into my remarks. I have been connected in capacities that have brought me in touch with these situations in some dozen cities, and, as I have stated above, I have found infinitely different situations in each. By this time, having had such experience, I have come to the following conclusions:

The central station should not retail any electrical appliances that sell for small prices; that is, fans, small motors, heating devices, lamps, glassware, fixtures, etc. Regarding electric signs and power motors, I am convinced it is by far the best policy for the central station to handle these two articles, as the contractor is forced to ask such a profit on same as would materially decrease the sales thereof, with a consequent holding back of the increase in the earnings of the company. I do hold, however, that it is well for the central station to let the contractor be aware of the fact that at any time he does not retail small appliances as mentioned above at a fair profit, the central station will immediately take up the sale of those articles at what they consider a fair profit. In other words, for the central station to act and cooperate with the contractor in such a way that will enable him to sell all of the appliances sold, so long as he does not sell at an excessive profit. It can be readily seen that the retail price of these devices can be maintained at a standard which allows a fair profit to the contractor, and still kept low enough to assure the central station of increasing its load continually.

Another point well worth mentioning, is the fact that, although many broad changes of policy touching the central station's relation with the public have been made, the public are still skeptical to a large degree of devices purchased from the central station, feeling that such appliances will use a maximum amount of energy, and not a minimum, as they cannot see why the central station will recommend an article which is the most efficient in its class, as long as it is their business to sell all the electricity possible. Of course, the fact remains that the public would

also be skeptical of what the electrical dealer might say, but the fact that his business is separated from the central station will be more liable to convince a customer that his suggestions are bona fide and can be relied upon. Especially in the more highly developed communities we find that the central station is very much of a business in itself. For instance, the central station advises the owner of a large factory to turn out furniture instead of electricity, purchasing its electricity from those who make a specialty of its manufacture.

Regarding the subject of interior wiring, there are today few central stations doing wiring who do not do it at a loss to themselves; and every year sees many of these stations undergoing a radical change in this respect, selling out their stock to the local contractor and making such changes in their policy as will enable them to secure the same amount of new business without doing any wiring inside of the service connections. If central stations would charge customers for whom they do wiring a profit of only 10 per cent on the job, it will be found that a good, up-to-date electrical contractor can do the job for the same money or less, and make more profit on it than the central station. This, because the electrical contractor does nothing but electrical wiring, while the central station does electrical wiring as only a small part of its work. And it will be found that in cities where a good city inspection bureau is maintained, the contractor does a better job of wiring than the central station, as it is the custom of the central station to take the job very cheaply, and then, necessarily, do the work cheaply in order to break even.

As mostly all up-to-date central stations now have an up-to-date new business department it rests to a large extent with the members of that department to secure the cooperation and retain the good will of the local contractors. To begin with, it is a great help to the local contractor to have the central station adopt a policy such as I have outlined, namely, sell only electricity, besides signs and large power motors, which the ordinary contractor does not care to handle, on account of the amount of money involved and the size of the resulting account. On the other hand, the new business department should endeavor to instill into the contractor the fact that he should not depend on the central station to do all of the advertising, and get all of the orders with no expense to himself, but when he is notified of a prospect for something in his line he should be live wire enough to get out with his catalog under his arm and make the sale himself, many times without the aid of the new business department. Unfortunately, where the new business departments have been made highly efficient, the tendency of the contractor to sit down and wait for business to come to him is very marked. He should be encouraged to do his own advertising, and in that way profit by its conjunction with the advertising done by the central station, and also by manufacturers of heating devices and apparatus. On the other hand care should be taken at all times not to coerce a contractor into making any kind of sale that does not yield him a fair profit as this will immediately turn him into a disgruntled and dissatisfied member of the electrical family; then when a customer happens to mention the fact that his electric bill for last month was too high, instead of trying to show him that it was not, he will agree, and thus make for the central station, a dissatisfied customer. By all means have every contractor in town your friend. Let the other things come second, but have them all what we call in Muskogee "progressives," which is another name for "boosters."

If the situation can be handled diplomatically, and there are enough contractors in the city, have a good, live contractors' association; although great care must be taken to keep it from acting as a "boomerang" and boosting prices for work and appliances so high that the increase in connected load soon begins to drop off. However, being tacitly handled, the association can be made a friendly series of meetings and a help to both the small and large contractor. Through this association a contractor can learn what it costs him to do business, the ignorance of this fact being what accounts for so many unsuccessful men in the electrical contracting business. If he only knew it, each competitor is his best asset, and second best is the data book and literature issued by the National Electric Contractors' Association, which can be procured by any member thereof. It is plain to be seen that every financially sound electrical contractor in the city is a profitable man for the central station to have, and in a city where every electrical contractor is making a success in his business, so will the electrical development continue and incidentally the revenues increase from the sale of electricity. In my opinion, the sooner all of the electrical interests are combined and knit together in closer relation, the sooner the ideal conditions wished for by many central stations may be brought about.

I find I have said nothing regarding the manufacturer. From a central station standpoint I will say this: Let the new business men especially, and also the heads of the different electrical departments, become acquainted with all representatives of either jobbing or manufacturing houses. In this way they may keep in touch with material and apparatus that is being sold, and by establishing a friendship with these representatives promote the interests of the central station away from home. Many times the manufacturer's representative comes to town to work on a proposition that he expects to place, and ninety-nine times out of a hundred it is for the benefit of the central station; and if the central station employees will join with him and heartily push his game along, they will find him less and less apt to make suggestions along the line of isolated plants, and in my experience, advise the central station when he finds an isolated plant being considered.

G. R. Trumbull, Commercial Manager of Meridian Light and Railway Company, on The Central Station Securing Contracts for Heating Devices and the Contractors Taking Care of Wiring and Sale of Motors.

In regard to the relationship between the manufacturer, central station and contractor, there is a broad field for discussion with but one result and that is that there must be absolute cooperation and friendly feeling among all three, especially the latter two. One sentence of your editorial in the December issue embraces the true facts, and that is, the contractor and central station are so closely associated in their work that the interests of one cannot be disturbed or improved without effecting for the worse or better the interests of the other.

The central station should make every effort possible to establish friendly relations with the contractors. It means more sales, greater profits and a better impression with the public, for the contractor can become the most harmful knocker that a central station can have, due to his closer knowledge of everything electrical. While on the other

hand, a contracting firm can boost a central station considerably in the public estimation by overcoming criticisms and satisfying complaints which the central station never hear of.

The time has come when every central station must realize that their new business increase and right to consideration depends upon good service and the good will of the people. New business campaigns for the sale of electrical appliances and wiring of houses, etc., can be made, and are being made as successful where a reasonable profit is realized upon every sale. This enables and encourages the contractor to compete with the central station on a friendly basis. The most satisfactory arrangement I have found so far has been for the central station to sell heating devices, etc., and to allow the contractor to take care of all wiring and the sale of motors. The new business department is very active in getting the contract for wiring and sale of motors, but the actual labor of installing and the profit of the sale is turned over to the contractor entirely.

Under such conditions, when the central station is doing everything possible in their power to help the contractors, they on the other hand should insist on houses and stores being wired in the best possible manner, that is, make an effort to induce the prospect to install baseboard receptacles for fans, vacuum cleaners, heating devices, etc., and by all means they should study the proper position and arrangement of lamps and the type of reflector and lamp to be used. The average contractor never takes into consideration the color of the walls in a room, the height of the ceiling or the height of lamps above the working plane. More dissatisfaction of electric lights in the home and store and shop is caused by this ignorance or indifference displayed by the contractor in making the installation. It is just as necessary, if not more, for the contractor to study illuminating engineering as the solicitor of the central station.

The contractor should consult with the illuminating engineer of the central station in regard to every wiring installation and likewise with the power expert in regard to motors for in nearly every case it means more money for the contractor and a satisfied customer for the central station. I say by all means there must be harmony and co-operation among all three if the greatest results are to be obtained and that is what we are all working for.

L. G. Gresham, Asst. General Manager Appalachian Power Company, Bluefield, W. Va., on Reasons Why Central Station Should Handle All Electrical Appliances.

In setting forth my ideas supporting the central station as regards the proper relation that it should maintain toward the manufacturer, electrical dealer and contractor, I shall touch principally upon the handling of appliances, such as small motors, heating devices, washing machines, etc., which the central station is vitally interested in pushing. As a general proposition, I thoroughly advocate the handling of all electrical appliances by the central station, First: Because the central station is directly interested in the sale of electric current and such appliances as will consume current. Second: The electrical dealer and contractor devote most of their time to the supply and wiring end of the business and therefore are not primarily interested in the sale of current consuming devices. Third: The dealer and contractor, as a rule, have not sufficient working capital to justify keeping a complete stock of appliances, such as motors from 1 to 25 horsepower capacity, flat irons, coffee percolators, toasters, washing machines, etc. Fourth: The total working capital of the dealer and contractor should be invested in the business in which they are directly interested, thereby insuring the greatest return on investment. Fifth: The margin of profit in handling appliances is so small that the dealer and contractor cannot afford to maintain a soliciting force pushing such sales. Sixth: The central station can afford to install a complete stock of appliances, as they can buy at much closer prices and can afford to sell at a narrow margin of profit, because their livelihood is not dependent upon such sales. Seventh: Most central stations maintain a corps of New Business men whose duty it is to sell current consuming devices. These men are trained in the most efficient method of installing motors, signs, interior and exterior illumination, and other appliances, in order to produce the highest operating efficiency, thereby satisfying both the consumer and the company and reducing the number of complaints to a minimum. The New Business men must have a complete stock at their disposal to make prompt deliveries, and trial installations, if necessary, to secure the greatest volume of business. Eighth: In over one hundred central stations with which the writer is conversant, the central stations have been forced to take the initiative in the sale of appliances, due to lack of effort on the part of the dealer and contractor to handle such sales satisfactorily.

With these facts confronting us, it is necessary that the sale of appliances be primarily under the control of the central station and that a complete stock be maintained and net retail prices upheld as far as possible, except in extreme cases, like a flat iron or other appliance campaign, where a certain amount of publicity must be given in order to educate the public to the use of such appliances. If the dealer and contractor feels justified in handling appliances, hearty co-operation should be extended him by the central station, and in this case, the net retail selling price should be maintained by both parties. A spirit of co-operation and team work should exist between the central station and the contractor, as their work is very closely allied. Otherwise a certain element of friction will exist, which will be more or less detrimental to both. The central station should keep in close personal touch with the dealer and contractor and vice versa, advising each other of all new building operations and other developments of mutual interest. Thus the dominating spirit of team work is at once recognized and that each is working for the mutual advancement of the other.

The relation of the manufacturer to the central station and contractor is of vital importance, as the manufacturer stands ready at any and all times to assist in working out commercial and engineering problems. This is especially true where unusual conditions arise and the central station or contractor has not the available information to cover the subject. For example, in soliciting power business, the manufacturer stands ready to work hand in hand with the central station and contractor by sending a specialist to assist in working out details as to which type of motor is particularly adapted for each class of work, together with the best drive, in order to secure the most economical results.

With this system of co-operation, the central station secures the power contract, the manufacturer the motor order, and the contractor the wiring and installation work.

Thus, each is profited by handling the commodity in which he is directly interested. The entire electrical organization is working for a common cause, that is, the upbuilding of the profession, and so long as the central station, dealer, contractor and manufacturer "pull together," the results will be most gratifying.

The above represents conditions from my own experience in connection with a great many central stations all over the United States, and especially with the Byllesby Company. In almost every property in which we operate, we are forced to handle appliances, although we do not like to, as we would rather co-operate with the contractor and receive his support in this direction, but the lack of capital and initiative on their part is such that we are forced to "take the bull by the horns" and go into it ourselves in order to get results. We endeavor to apply progressive ideas to all of our properties and I believe that our New Business organization is the best in the country, no exceptions, and this has been brought about by keeping in close touch with all situations, securing specialists in every case who know their business and with one idea in view, namely, to have the interest of the company and public at heart.

Philip S. Dodd, Secretary Commercial Section of N. E. L. A., New York City, on Mutual Effort for Mutual Good and the Power for Betterment of Business as a Whole Worked by Our Commercial and Social Organizations.

The question of trade relation between the central station, the jobber, the contractor and the manufacture has been for many years much debated. While some relation along co-operative lines has been recognized as a vital necessity to the growth of the electrical industry, the point for debate has always been as to just what this co-operation could be and just what lines it should follow. It is recognized that the central station must to a certain extent, take the initiative because of the fact that it is their current which will be used for the operation of all current consuming devices sold.

There are so many points to be considered and local conditions vary so greatly, that the question of co-operation, along any line, must naturally be a question to be discussed locally rather than as a national proposition. Either locally or nationally the question can logically be arrived at satisfactorily only from one view point, namely, "The greatest good to the greatest number." By the "greatest number" is meant not only the manufacturers, the central stations and other distributors of energy and devices, but the public as a whole, the ultimate consumer of electrical energy and electrical products. Admitting that the use of electrical energy through some form of current consuming devices, confers a benefit on the vast majority of the individuals who go to make up our population, the question is, how best to increase the uses of electricity and educate the masses to a fuller knowledge of the benefit that lies at their hands.

Considering the question from the viewpoint of industrial economies, it would seem that this education could be best handled through co-operative effort on the part of the various interests who are endeavoring to increase the sale of current consuming devices or electrical energy. Since it is clear that co-operation is only possible where each have equal opportunity for profit in proportion to investment or effort expended, it would appear necessary that the first step toward any practical move for development would be absolute harmony among the various allies, but sometimes warring interests. Agreements must be reached and adhered to, as to the definite field of operation of each and arrangements made which will give to each a fair return, and an equal opportunity. Once this is accomplished the means for development of the market are many.

To the initiated, electricity is a simple servant, easy to handle and control, and always ready for work at a pull of the switch or a pressure of the button, but it must be remembered that to the greater majority of the public, it has been a thing of fear, a stupendous mystery and that increase in its use must come through education, education along the lines of safety, economy, healthfulness, readiness and sureness of service and the like. Education is more vital to the increased use of electricity than to the marketing of any other commodity which is in general use by the public today. Efforts toward that education are being made in many directions and in many different ways. Through publicity work on the part of the various local organizations, such as the Jovian Luncheon Clubs, Luncheon Club branches of the National Electric Light Association Company sections, Development Leagues, etc., and the effort that is being made by them in every progressive city, where it has not already been started, to publish co-operatively an electrical page in the newspapers, by their co-operation with Boards of Trade, Chambers of Commerce, to advertise and assist in the development of the city itself, by the use of electric signs, improved street lighting, etc. etc., and in several cases where it has been successfully demonstrated that it is possible to arrange with school boards for the introducing of electrical courses in the schools and colleges.

The Commercial Section of the National Electric Light Association is doing a number of practical things for the development of the industry through the preparation and distribution by some of its committees of publications of educational value covering the wiring and lighting of homes, the lighting of factories, workshops, etc., the lighting of streets, sign lighting, etc., and by the dissemination among its members for use in their work with the public, of information pertaining to commercial practical selling methods, data relative to current consuming devices, power data, etc. etc. Its future plans include a cumulative index of the above together with a complete catalog of current consuming devices and properly indexed digests or abstracts of articles of commercial interest appearing in the current technical papers.

All this work being co-operative not only on the part of the operating companies but by them with the manufacturers, the jobbers and contractors, is effecting the entire industry and is gradually but surely bringing about more harmonious relations among the different interests and settling day by day the question of trade relations which until only recently has stunted the growth of the business. We are all learning that real development comes only by the use of intelligent effort in educating the public and by active co-operation with the jobbers, contractors and manufacturers, and the jobber, contractor, and manufacturer that it is not only desirable but necessary that they co-operate with and secure the full co-operation of the central station.

The Commercial Section, the Jobbers and Contractors Association, the Jovian Order as a whole and through its

local organizations and the various other local organizations, all are working co-operatively among themselves and in many instances with each other towards practical concatenated effort for the development and betterment of the business as a whole. While individual publicity is logical and valuable and will without doubt always be continued, the tendency is toward mutual effort for mutual good, not only along publicity lines, but in many other channels. The time is not far distant when this working together of the various interests will be settling quietly and naturally the differences which may appear difficult in the extreme to us all to-day.

The tendency of the times is for "getting together" and toward organized, rather than individual effort in development work, so that the question of "Why should I join the Jovian Order, or the National Electric Light Association" is beginning to put itself into the class called "foolish." Two heads are better than one and 10,000 better than two. No one man can afford to lose the opportunity for the securing of information such as the committees of the Commercial Section of the National Electric Light Association is disseminating, which has a direct bearing on the problems which confront the commercial men of to-day, nor the harmonious relations with his fellow men and practical help offered by membership in the Jovian Order. All together all the time for everything electrical, is coming to mean more and more each day to all of us for though there are not many of the mighty—the many are mighty.

R. E. Flower, Manager, New Business Dept., Mobile Electric Company, Mobile, Ala., on Results of Central Station Co-Operation with Electrical Contractors.

I read the editorial in your December issue of Southern Electrician on, "The Central Station, the Contractor and the Manufacturer" with the feeling that a discussion of the subject should bring out some points valuable to all parties concerned, but especially so to the central station. It pleases me to rearrange the title of your editorial by placing the manufacture first, the central station second, and the contractor last, for logically the central station is the contact point between the other two. The contractor looks to the central station for the opening of new fields and more diversified application of electricity in order that his business may increase and become more profitable.

It is this development and seeking after new business on the part of the central station that compels the contractor to go to the manufacturer for his supplies and materials. It is upon this development that an increase in business for the manufacturer depends. The central station is therefore the connecting link in the matter of co-operation between the manufacturer and the contractor.

This subject is of vital importance to the central station, for the efficiency of its commercial department depends upon co-operation with the contractor and the manufacturer. This Department can do its work best only when it has the confidence and co-operation of the contractor, and the assistance and support of the manufacturer. However, before any degree of co-operation can be had with the contractor, the Central Station must win his confidence by fair and square dealing without discrimination or favoritism. The manufacturer in the same way must impress the central station and the latter in turn will bring the other two into a more friendly relationship.

Whenever possible the New Business Manager should bring about an association of the contractors in his city. If the time is not yet ripe considerable good may be done by calling frequently upon the various contractors and talking over with them the present and future business, at all times trying to win their confidence and personal friendship without favoritism, for favoritism arouses jealousy, and jealousy means death to the spirit of co-operation.

In Mobile the contractors are very friendly to our commercial department. Their confidence in it is shown by the fact that many of them come to us for assistance in power and illuminating engineering problems. We try to co-operate with them at all times. During our last house wiring campaign, we called over the telephone each morning, every contractor and gave him a list of the coupons deposited the previous day, in order that he might call promptly and figure on the work. One of the contractors became so interested in the campaign that he bought fifty Sunday papers, and clipped therefrom our advertisement in order that he might leave this, with the coupon attached, with all prospective customers to whom he furnished bids. As a result of this co-operation, not only with our commercial department, but with the consumer, this contractor secured as much business as all the other contractors put together.

Another contractor, who used to fight all ideas of co-operation with our new business department, is being slowly won over. When he first went into business he too some work at a price which made it necessary to sacrifice good workmanship and efficiency of installation. In these instances we went to him and told him that he was not treating himself nor the consumer right, in doing this kind of business. He at first felt that we were a bunch of knockers and refused to have anything to do with us. It was not long, however, before we noticed that he was putting in a much better grade of work, and whenever we ran across one of his installations with a certain degree of merit we dropped him a line, or called upon him personally, and told him how we appreciated the good work he was doing. This contractor is now soliciting the wiring of houses on a three mile extension. He has signed up the contracts for wiring these parties by putting forth the advantages and conveniences of electric light, this will mean to us an increase of about fifty resident consumers.

George Williams, of H. L. Doherty and Company, New York, on Periodical Meetings of Electrical Supply Men, Manufacturers' Agents, and Central Station Men to Solve Local Problems.

I know of no situation where it would not be more profitable and pleasant if the electrical supply men manufacturers' agents, and central station operators would have periodical meetings where they could get together and solve their local problems. They are all engaged in the same business, though in different phases, but have many things in common. In several cities in which I have had the opportunity of becoming familiar with local electrical conditions, the central station is retailing heating appliances and electrical supplies on too low a basis of profit, the supply men in those cities asking too high a price for the same goods. Neither the central station company nor the supply men are properly exhibiting these goods and this condition alone would suggest a meeting

where they could all find means of promoting the business in general to everybody's advantage.

There is so vast a field for sales in every town that there is much more to gain by co-operation than by the isolated efforts of each. As a policy, I am of the opinion that the central station should not attempt to undertake a wiring business, but some central stations have been forced into it by the condition of not having an up-to-date wiring concern in their town,, while on the other hand some of the central stations have attempted contracting business when it was not justified.

Sufficient examples of the good results from the co-operation I suggest, are brought out in the monthly literature of the National Electric Light Association and if the combined electrical interests in any town are inclined to get together they can easily supply themselves with the records of the experience of others who have profited by co-operation.

W. H. Hodge, Publicity Manager of H. M. Byllesby & Company, Chicago, Ill., Suggests More Activity on the Part of Local Supply Houses and Contractors in Electrical Development.

I am very glad, indeed, that the SOUTHERN ELECTRICIAN is to give the matter of co-operation between manufacturers, supply houses and central stations, attention, because it is one that should have very vigorous treatment. In many cases there has been apparent co-operation between manufacturers and central stations, but far too many instances of local supply houses and contractors not having participated adequately in the general work of development. I do not care at this time to attempt to find the cause of this, but it is very clear to me that something should be done and done at once, to bring about closer relations than now exist.

Every one knows that when we wish to make a certain line of business a factor for public good, care must be taken to insure a reasonable compensation for those engaged in that line. I think therefore that local supply houses and contractors play a very important part in electrical development of any section and anything that you can do to work order out of the present chaotic conditions will be of great value to the industry.

A. Larney, Manager New Business Dept., Consumers Power Company, St. Paul, Minn. Electrical Heating Devices Handled by Central Station vs. Handled by Electrical Dealers.

In regard to the subject, "The Proper Trade Relation Between Manufacturers of Current Consuming Devices, Central Stations, and Contractors," I would say that it is generally conceded that there has been no suggestion offered to date which would permit the handling and placing of current consuming devices by contractors or others, and do it as successfully as the central station. This is for the simple reason that any other agency selling the appliances must confine their effort to the margin of profit on that particular appliance, whereas the central station receives a revenue from the use of the appliance on their lines, which may run into years, and, of course, the profit greatly exceeds that of the electrical dealer or contractor. Again, there is another very decided advantage to the central station which the contractor does not share in, namely, the use of these current consuming devices on off-peak periods which is practically a power load, but paid for at the lighting rate, and in addition, every successful and practical electrical appliance tends to popularize electricity and further in a general way the interests of the central station. On the other hand, there are a number of benefits obtained when all appliances of this kind are handled exclusively by live, aggressive dealers and contractors, for the central station is relieved of many troublesome merchandise accounts and the complications that follow efforts to collect bills for same in connection with regular current bills. Also the question of credits and the charges of discrimination where credit is not extended and cash payment insisted upon. Again, many states have Public Utility Commissions who thoroughly investigate all central stations under their jurisdiction, and it greatly simplifies matters and saves many complaints and inquiries by being free of the troubles in connection with this proposition; however, it must be borne in mind that the greatest return cannot be obtained when revenue alone is considered, unless the appliances are introducd by the central station.

There is another aspect of this case which is well worth considering. Practically every properly managed company has a well-organized commercial department, continually seeking the co-operation of electrical dealers and contractors, and affiliated trades that are interested in the electrical development of the community. Since many of these contractors have been long established and have considerable investment in their business, it is hardly fair for the central station to deprive them of the profit received from the sale of appliances by entering into direct competition with them, and then expecting their active co-operation in all other matters in which they do not compete.

I have had experience on both sides of the fence, both selling appliances direct from central station display room, and in other properties encouraging the introduction of current consuming devices by extending hearty co-operation to the local dealers and contractors through solicitors calling upon them frequently with a list of prospects secured during an ordinary canvass and then assisting them and please the prospect. Where the contractors are alive to the situation this latter arrangement works very well.

A. F. Douglas, New Business Manager of H. M. Byllesby and Company, Portland, Oregon.

My opinion regarding the relationship of the central station to the manufacturer and contractor and our policy, is one which might be called friendly co-operation between the manufacturer and contractor. We are always ready to listen to any suggestions they might have to offer and to consider the same. Should their ideas in any way be of benefit to us as well as themselves we are always ready and willing to work with them. We have received a great deal of assistance from manufacturers and contractors in making our various campaigns a success. The manufacturers have always been ready and willing to assist us whether it be from commercial or engineering standpoint. We try to be fair and reasonable in our demands from them and in any particular campaign or installation in which they might assist us we reciprocate by giving them some business. That is, in the way of giving them an order for various appliances.

Cecil Toone, Kent, Eng, an English Consulting Engineer and Authority on Central Station Subjects in the United Kingdom. Discussion on the Central Station, Contractor and Manufacturer.

At the kind invitation of the Editors of SOUTHERN ELECTRICIAN the writer will discuss the impressions

he has gathered concerning the present and probable relations between the above three parties. The complainant of the group is undoubtedly the contractor. The central station and the manufacturer are both in an impregnable position; the former provides electrical energy and is competent and willing, if needs be, to sell and install apparatus for its utilisation. The maker manufactures apparatus and accessories and is not at all concerned whether the central station, the contractor or he himself sells them to the user so long as the sales are effected. The contractor, however, is in a weak position—he depends essentially on the central station which has made his business possible and the station and the manufacturer are, at any moment, able to assume completely his functions and, in some cases, have virtually done so. It therefore appears superfluous for the contractor to talk loudly of his rights—he has unfortunately no means of enforcing them.

As the electrical field has extended, installation business has become more valuable and disputes as to its distribution have naturally become keener. Further, the metallic filament lamp crisis undoubtedly formed the final incentive to a number of our stations to encroach on the contractor's domain. If not looking for profit on the actual installation work itself, the station has often found it necessary for its rapid development to take over a large amount of contracting work, owing to the more or less unsatisfactory and lethargic manner in which the latter had hitherto been executed.

The central station standpoint is that the supply authority is in no way beholden to the contractor. It can make its own arrangements with manufacturers and consumers and can popularize and install plants without any aid from the contractor. Its own publicity arrangements can easily be extended to cover the wider field. It is, by considerations of business equity, quite prepared to allow the contractor to remain in free operation so long as he carries out work to the satisfaction of the station and its consumers. So great and permanent, however, is the central station stake in a satisfactory wiring net work and in satisfied consumers that it will tolerate none but the highest class of work from the contractor.

There is no reason why contractors should reap a heavy benefit from central station activity in developing electrical demand and popularizing various apparatus unless they are prepared to render active assistance in this matter and to devote equal care to every job—whether "fat" or "lean." In the past, contractors have undoubtedly shown a tendency to pick and choose between jobs greatly, of course, to the disadvantage of the central station.

The contractor's arguments are that he is subject to throat-cutting competition, from ironmongers, plumbers and low grade wiremen, made possible by manufacturers permitting such persons to handle their goods and by central station engineers and even insurance inspectors passing their shoddy work. There is no doubt that this complaint is largely justified and, where such a state of affairs is existent, high class contractors obviously cannot compete. Similarly, if the station inaugurates a reduced-rate wiring department, the contractor is forced to cut prices by using poor material. Again, as a result of electrical exhibitions and the activity of manufacturers' publicity departments, all makers are now doing an important direct retail trade and at terms which are often as low as, or actually lower than, those given to contractors. This constitutes a further compulsion on the latter to use low-grade goods.

The manufacturer's position is, as already remarked, one of great independence. He is indispensable to the central station and is quite competent, financially and technically, to work independently of contractors. Indeed he far prefers to deal directly with the client in all cases where large or specialised plant is required. Such work falls outside the capabilities of most contractors and, as regards wiring and such work—which is being increasingly regarded as the limiting activity of most electrical contractors in this country—most reputable manufacturers now refuse to accept such contracts or, if compelled to do so, at once sub-let them.

Suggestions and Prospects. The average electrical consumer's trust in his central station staff is implicit and it is the business of the latter to see that this confidence is never abused. On this account, the supply station is, at once, strongly tempted to enter the contracting field and is situated in a commanding position should it decide to do so. It is fairly generally admitted that some radical change is imperative in the present relations between central stations and contractors (for reasons already cited, the manufacturer's position is comparatively simple) the present breeds of contractors, from the second-raters downwards, must be "killed" or "cured" and it would be to the mutual benefit of both parties if the less drastic course could be adopted.

The chronic depression of all but the largest electrical contracting firms—induced by hard treatment in the past and gloomy prospects for the future—might, according to a number of the victims, be removed by sympathy and help from central stations. This may, and should, be so but, before active collaboration between supply engineers and contractors can become general, the latter must be able to provide a guarantee of satisfactory service. This important matter has been greatly forwarded by the Electrical Contractors Association of this country—a body which excludes all but high class firms from its ranks and which is making vigorous efforts to enforce the employment of qualified and individually responsible workmen and foremen. So far the most demonstrative action of the Association has been the institution of legal proceedings against certain municipalities engaged in wiring work and, though these proceedings are justified and have, so far, been successful, they hardly constitute an augury of peace and cooperation. The E. C. A. has wisely decided to permit none but first class work to be executed by its member firms but the complementary step, necessary to make this policy effective and to exterminate "shoddy" contractors, lies in central station engineers refusing to pass installations put in by the latter. Under present conditions, large responsible contractors will confine their activity mainly to Government and public contracts and, in the ordinary domestic field, the "cut" work of the incompetent or unscrupulous contractor will predominate wherever it is permitted.

The Incorporated Municipal Electrical Association has, during the past two years, been endeavoring to promote a bill sanctioning the organization of wiring and fitting departments by municipal supply undertakings. It would certainly appear that such a use of ratepayers' capital in competition with ratepaying private traders is distinctly unfair and the proposed bill has met with such opposi-

tion from contractors and Chambers of Commerce that it will probably be dropped. A company-owned supply undertaking can engage in wiring and fittings supply with far more propriety than a municipal concern but, in either case, it is desirable and, in the latter case, morally essential, that the station should execute such work only at local market rates. The policy of cutting prices by central stations is unnecessary and unfair yet, as the law at present stands, municipal concerns cannot institute trading wiring departments though "free" wiring inflicts a far heavier damage on local contractors. (It is fair to remark that where free wiring is in vogue the service of contractors has usually been exceptionally unsatisfactory.)

An argument in favor of the retention of the contractor is that in many medium sized concerns, the total amount of wiring work would not justify a really competent station staff to take charge of it. On the other hand, the same argument applies to any local contractor and an emergency muster of station hands is likely to produce more satisfactory results than the small contractor's staff. In many cases, the establishment of a competent central station wiring and fitting staff, too elaborate for the immediate needs of the concern, would soon be justified and fully occupied by the extensions which they could work up.

An interesting proposal for "mending" contractors suggests that the station engineer should meet contractors at intervals to discuss improved apparatus and canvassing methods and results; that the station publicity literature should be distributed through approved contractors and over-printed with their name and address; and that contractors' workmen should be instructed by periodic practical discourses and the distribution of leaflets giving wiring diagrams, rules, practical hints, new suggestions, and so on.

Some English stations have appointed "authorized" contractors. This, so long as the choice is unbiased and not individious, is a recognition of merit and amore or less definite guarantee of prosperity which induces confidence in the client and, besides protecting the contractor from the unscrupulous competition of the "shoddy" man, gives him an incentive to work his field energetically. In one important town in the Midlands, the following excellent system is in vogue. The consumer explains his wants to the municipal electrical engineer who then draws up and issues a specification to all contractors. Tenders are sent to him and are then submitted to the consumer for selection. The completed work must be passed by the station mains engineer before connection and payment is made by the station in the first place, the amount being added to the next quarterly bill sent to the consumer. The fundamental requirements of the station, as regards materials, etc., are strictly enforced and all the contractors have been warned that any sharp practice or unsatisfactory work will at once lead to the supply department embarking on a vigorous scheme of municipal trading.

The assumption of such a firm attitude by the station is justified and, so far as the writer's observations go, it is perfectly satisfactory and equitable to all parties. The station cannot afford to allow its consumers to be mulced in quality or in dollars and cents. On the other hand, its primary business is to sell electrical energy and, if the means and apparatus for its utilisation are satisfactorily provided by contractors, the station would do well to confine its activities to its more legitimate aims. In the publicity field, the objects of the station and contractor are identical and collaboration must be mutually beneficial. Manufacturers appear likely to become more and more independent of contractors, particularly in power equipment and, as it is to the client's advantage to have expert advice in this important matter, the tendency cannot be regretted, for few contractors can cater properly for the ramified and ultra-specialised requirements of the industrial power field. In designing smaller electrical apparatus, manufacturers should consult central stations engineers to a greater extent than has hitherto been usual. The latter are closely in touch with large numbers of consumers and have excellent opportunities for ascertaining their exact needs. The position of the electrical contractor in this country is not one of strength but, given a degree of reform and diplomacy which appear to be forthcoming, there is no reason why their past vicissitudes should not be repaired and their cooperation with central stations become invaluable though limited in scope.

From the Manufacturers' and Electrical Dealers' Viewpoint.

Oscar C. Turner, President of Southern-Wesco Supply Co., Birmingham, Ala., manufacturers, importers and jobbers of electrical machinery and supplies, on Trade Relationship of Electrical Interests. Facts plainly stated by an electrical man of years experience which can only be blotted out by proper co-operation.

In line with the discussion to appear in SOUTHERN ELECTRICIAN on the relation that now exists between the jobber, supply dealer, electrical contractor and the central station selling current consuming devices and cutting prices on same, I am forced to state that after a good many years of study on this matter, I believe that the central station is in its relation to these interests out of its place and should limit itself to selling current, which, after all, is its primary aim. The natural course of merchandising electrical apparatus and supplies should be from the manufacturer to the jobber, then to the contractor or central station and others in the electrical line, and then to the user.

I, of course, appreciate the many arguments that the central station has put forth, all of which mean that they want to get current consuming devices on their lines. I believe if the same amount is spent by the central station in advertising, exploiting and selling through supply dealers or contractors, that the results would be as good. The central station is naturally the largest factor in the electrical business in every community; it should do everything possible to foster the electrical business there in a broad and not in a selfish manner. Whatever it may do that helps the contractor or helps the supply dealer or jobber, reverts to its good. I believe it is unfair for the central station to offer any goods of any type at a price that does not give the jobber and contractor a living business profit should they meet the price that is offered by the central station. The central station should give its entire time toward taking proper care of its customers, and its new business department, the advertising department, or, its many other departments should be turned into the development of this same work in conjunction with the natural factors, the jobber, supply dealer and contractor.

Years ago in the matter of incandescent lamps there was probably some reason for the central station demanding that the lamps used on its circuits be of certain grade. This brought around, first, the handling of lamps and afterwards the giving away of lamps in some cases, and

this point if it was well taken then, has certainly not been well founded, for in later years when lamps have become standardized and of practically the same grade, and when the high efficiency and high candle power lamps came out, the central station in a great many instances has done a most glaring injustice to the contractor and dealer by continuing the practice. The contracts drawn by the manufacturers of incandescent lamps allowed the cutting of price by the central station, but required an absolute maintainance of price by the other users. Numerous instances may be cited of central stations offering these goods at what was supposed to be their cost where it worked serious injustice and unfairness to other electrical interests in the different towns. Not only have the central stations allowed this in their own cities, but occasion after occasion has arisen where people in other towns have gone to these stations and carried the cut price lamps home with them. This has naturally caused numerous embarrassing situations for the supply dealer and contractors when their customers who had bought from them, afterward find that the central station sells the same product at a lower price. I believe this was one of the main reasons that the department of justice took up the fight on the lamp combination.

A few years ago it was a universal practice for central stations to do wiring and maintain wiring departments. This was found to be a losing game, and has been almost entirely discontinued. I believe that experience has shown that the contractor does better wiring than the central station department, because he is in closer touch with wiremen.

I also believe that the factories manufacturing current consuming devices and who will not sell a central station except with an understanding that they maintain a resale price, have always been those of the manufacturer of the most merit and their goods of the higher grade.

The rates of most central stations for current are not high or unreasonable. Yet I submit to the central stations that when they make an unbusiness like profit and advertise it to their customers that they are selling any line of goods at cost, it might appeal to some business men who buy current from them, that such a station is making too much profit on the current, and if there is a loss by selling goods at cost on a certain line, naturaly it must be compelled to make it up on something else. While this may appeal to some in this way it is not true, for the central stations charges for current in nearly all cases are reasonable and they cut the price on some current consuming device, like other merchants, make a leader of something else. Were the city councils of the different cities in the United States to begin to allow the isolated plants in every community to furnish electric current in their several localities at a considerable reduction under what the central station is selling its current, you would hear a wail go up from the central station stronger and wilder than has ever come up from the supply dealer, yet the isolated plant has just as much business selling current at cut prices as the central station has in selling current consuming devices at cut prices.

It is a foregone conclusion that it does not cost a contractor and supply dealer as much to do business, or as much to sell any article of a current consuming nature as it does a central station, and the statement of a central station that a contractor charges too much for his goods is not based on business logic. Picture for a moment the difference between a soliciting force of the central station out selling irons and that of a contractor. In many cases the central station gives a solicitor as much as a dollar for every iron he sells, besides offering the iron at practically cost. Were this same proposition made to the contractor and the same amount of work in advertising done by the central stations, I believe more irons would be installed. There should be a closer working arrangement between a contractor, central station and supply dealer, for their objects and business are to a great degree identical. The central station must make the way for the other two to succeed and should by every fair means at their hands, foster and help build up the business of the contractor and the supply dealer. Exploiting or demonstrating of current consuming devices done by the central stations should result in orders being placed with its contractor or supply dealer.

The electrical business is a newer business than most others and this accounts in a large measure for the constant meddling by the central station in the business of the contractor and supply dealer. Very seldom do you see a water works company offering to sell bath tubs or water hose at cut rates. Further, it was only a few years ago when doctors used to make all of their own pills and medicine; this, however, has disappeared until now the druggist is a decided factor in our business life. If the central station desires to go into the electrical contracting or supply business, it should do so in reality, pay its license as other contractors do, and have a separate store and let this department rest on its own basis, making it a business adjunct that must show a profit. I believe the reason why so many contractors in the electrical line are weak financially is because of the unjust competition that they have had from central stations. The central station ought to sell current but it ought not to enter into the actual selling of accessories or current consuming devices other than by exploiting, advertising, demonstrating and turning over orders to the contractor and supply dealer. In this way they can easily guarantee to the public that they will not be overcharged for any article, and I believe the day is coming when this commercial co-operation that has been preached so thoroughly throughout the electrical fraternity will be a reality. A large degree of the credit for this is due the electrical fraternity, "The Rejuvenated Sons of Jove." This fraternity of over 6,000 electrical men in every part of the country is working all the time toward commercial co-operation; their slogan is, "All Together All the Time for Everything Electrical." This should be taken up by every central station, and if they do they will find the contractor and supply dealer anxious and willing to co-operate with them.

Wm. Farr, President of the Piedmont Electric Co., Asheville, N. C., on the Possibilities for the Electrical Contractor.

In regard to the proper trade relationship between the manufacturer, central station and the electrical contractor, while we are not, at this time, as closely identified with electrical contracting as we were in the past, yet from the writer's own experience we believe that the central station has not given the consideration to the electrical contractor that he deserves in the sale of current consuming devices. The tendency of the lighting companies to sell electrical appliances at cost does not, we are sure, produce the desired result, and it takes away from the contractor the

opportunity and the desire to build up a business on the sale of appliances that would be not alone a benefit to himself, but also to the central station.

In a large number of small towns the contractors have not shown themselves aggressive. Their places of business are on a side street or in a basement, and they are not good advertisers. The sale of electrical goods must necessarily be handled along the lines of other merchandise and as a large majority of the devices on the market are entirely new to the public they must not be alone shown, but demonstrated. We believe that if the contractor will get up on the ground floor; put in an attractive show-room and display his goods to advantage, he will find that he can handle the greater part of his appliances at a margin of not less than 25% profit. In a great many cases this is the margin of profit maintained by the central stations, although they attempt to blind the public by stating that they are selling at cost.

The average lighting customer would, we believe, much prefer buying his appliances from a dealer who devoted his entire time to that line than from a lighting company who claim they are selling at cost, which is not believed by the average buyer who always has a lurking suspicion that the appliances offered are not as economical as he could buy from a dealer, because a lighting company is necessarily interested in the sale of nothing but current. The gist of the whole matter is that the contractor, if he would sell electrical appliances in competition with the central station, should do so in the same way as has proved profitable in other lines of merchandise.

Marshall L. Barnes, President of National Electric Contractors' Association, on Co-operation from the Contractors' Viewpoint.

With the organization of the various associations in the electrical trades, and the rapidly growing order of the Sons of Jove, a spirit of good fellowship is being engendered and a rapid trend toward co-operation, which cannot but be of the greatest benefit to the trade and to the consumer. We are now taking the time to look over the situation, and find that too many years have been lost by friction. The manufacturers have been getting together in the various lines, and established a better and more profitable trade basis, the jobber has his association for the betterment of wholesale conditions and the contractor or retailer has an organization covering the whole country with the exception of two small states.

A few years ago there was practically only enmity existing among the competitors in these trades. Organization has brought them together, and the sociability that enters into the convention has tended to bring about a fraternal feeling that has developed a co-operative spirit that is, and will, accomplish most wonderful results.

The manufacturer, I believe, should establish prices which the jobber and contractor should religiously uphold. I believe the central station should confine its operation to the sale of its current, and that the contractor is the natural agent and solicitor. It is as useless for the station to do wiring at or below cost and sell lamps and other current consuming devices, as for a merchant to sell his goods without a profit. It is taking business from the legitimate dealer as well as from the stockholders of the lighting plant, and it is far from co-operative.

This trouble is, however, gradually disappearing, and it is hoped that in time, each line in the electrical trade will have its own field of operation to the general good of all. With an organization embracing among its membership the inventor, manufacturer, jobber, contractor, and engineer, in fact, all branches in the field of electricity, such as the Sons of Jove, which now has a membership of some six thousand, a work of co-operation can be fostered by such a fraternity. The work of this body is being felt more and more, and its recent rapid growth is largely due, not to the social end, but to the good that is being manifested in bringing together in a business way, those who are looking to the betterment of trade conditions.

The contractor is out with hands extended, to greet and work with all other branches of the trade, and this is inspiring a confidence and fellow feeling that will eventually, we hope, cast aside all animosity, that has so unfortunately existed in the past, and cement us into one co-operative body for everything electrical.

Mr. F. Bissell, President of the F. Bissell Co., Toledo, Ohio, on Relation Between Jobbers and Contractors.

This subject has been long before us and should have much more attention than it does. The writer read a paper before the Toledo Convention of the N. E. C. Association in which he called attention to the big profit in merchandising suggesting that it belonged to the dealer and should be taken over by him and rightly handled. Of late, the policy of some central stations has changed and there are a few who now attempt to give away merchandise in the hope that it will stimulate the consumption of current.

The field was never better for the contractor to take what belongs to him and in time it is probable he will take it. It will pay a handsome profit and we don't believe that a better service can be done for the trade in general than to promote, not only this fact itself, but also impart a knowledge to whom to conduct that part of the business. Not everyone knows how to sell over the counter, or to follow the customer to his office or his home, and the campaign of education will be long and hard. The subject itself will live, however, and from a "copy" view, if nothing more, it occurs to the writer that it may be of interest to a good publication like yours.

ABSTRACT OF MR. BRISSELL'S ADDRESS BEFORE N. E. C. ASSOCIATION.

The natural course of merchandise is from manufacturer to jobber, then to the contractor, central station and others, and then to the consumer. That it is advantageous to the contractor to buy from the jobber is an old statement and grows stronger every day. The time-worn story that jobber does concentrate merchandise, making a depot from which the contractor can draw assorted items on demand, that he makes a few shipments of many items, that he can always offer good railway facilities, that the contractor needs no large investment in merchandise and can devote his capital to other necessities in his business and that he can and on occasion does receive financial favors, all these things are true and are better understood every day.

That many things are now in the wrong and that we are far from the ideal is obvious, yet we believe that the trend of opinion and of events is in the right direction. The thing to do is to get together, but it is much easier to outline the present defects and the future perfections than it is to tell how to avoid one and to reach the other.

One of the first troubles is found in the jobber who does a construction business or runs a construction department. Then there are contractors who attempt a jobbing business, and for reasons equally sincere and to them equally satisfactory, yet who retain their construction business. Both of these men are detriments to their respective associations and have been the causes of the most serious obstacles in the working out of this problem.

Suppose the contractor has a scheme to eliminate the jobber and is successful. The jobber promptly retaliates, engages in construction and the latter case is worse than the first. Trouble from this source is already on us and, in some localities, the line of demarkation between jobber and contractor is very dim. All results are warnings in favor of better co-operation. Along this line of investigation it may be well to ask if the jobber is really a business necessity. No doubt exists in the minds of the jobbers themselves, although there have been some manufacturers and some contractors unkind enough or misguided enough to regard the jobber as not an absolutely essential member of society. For those who entertain such ideas it may be well to remind them that no one who is useless endures. The progress of events takes him out. Yet from the earliest history merchants who bought in bulk and sold in broken lots have been prominent and doubtless always were dominant in the business world, as they are today. Some things to today go from manufacturer to consumer but not very many. Judged from everything, the jobber is here to stay because he is a truly useful member of business economy, and when he ceases to be useful he will vanish. It may be helpful to appreciate that vanishing is not a monopoly.

Once more to review, it is true that if the contractor's goal is to be the construction business he needs the jobber, but if he aims to be a jobber himself he needs the manufacturer. Then when everyone becomes a jobber, what happens? What is to decide a contractor in his plan? Where does he look for an example? The relations between the manufacturers and the jobbers are not perfect, but that is another story. It is, however, as good as the relations between the jobber and contractor, but the relations between manufacturer and contractor are certainly bad enough to excite the condemnation of every thoughtful man. And right here we put our finger on the source of many of the reasons why the despised curbstone operator does not stay where he is said to belong.

One betterment which is coming rapidly is in improved internal business methods. Both jobber and contractor are keenly alive to these. The better methods include buying with regard to the profit which can be made when the goods are sold; better bookkeeping, collecting and paying; fewer open accounts either way; selling goods and doing work only when a profit can be made; and along these lines success is certain

Perhaps the greatest enemy to the contractor's success, particularly if he is a retailer, is the unwise attitude adopted by some central stations of giving away articles which consume current. For this there is no reasonable defense. Many manufacturers protest against this with varying vigor but some absolutely prohibit the slaughter of their articles which are controlled by patents. To one central station who offered to do big things for one manufacturer and who was entirely earnest and well able to carry out his suggestion, the manufacturer argued that instead of killing the article, why did not the central station take it out of the price of the current, which to him seemed the reasonable way to promote the current business. This was refused. Yet we all know that it is the right way to increase consumption of juice, as witness the power companies supplying current to big mills and factories. The consumer is waking up to the fact that he is the victim—that the present of a flat iron on a high rate is loaded and sure to explode and take a few of his fingers along with it.

Yet the central stations have some proportion of reason when they say that they are forced to do these things because contractors do not run retail stores, do not promptly take up with new ideas, some times attach too high a percentage of profit and thus kill the introduction of new devices, and other arguments with which you are familiar. The question for us is, are these arguments sound? If they are we must permit the central stations to go ahead on most any lines they chose, for we neglect the business and they have a right to it. If, however, we can show them that the sale of current consumers is actively solicited in their city by one or five or fifty contractors and that collectively much more is done than the central station could accomplish with its own corps of salesmen, then we at least have the opportunity to prove to the central stations that such methods are neither necessary nor profitable to them. This situation for the contractor and central station parallels that of the jobber with the manufacturer who goes direct to the consumer or to the contractor. Both methods will cease when they are no longer necessary. It is what men do, more than what resolutions they make, which determines business methods.

Now what is the general situation? Must we all continue until the electric business looks like the market for patent medicines where the jobber pays 60c. for a bottle which retails for $1.00 yet the consumer can buy it from the department store for 58c.? If so, what is the use? But we have unbounded faith that this is not so, that not only the nature of this business but the class of men in it will find ways to make money proportionate to the investment and the efforts which are now in it, and that these are great is well recognized.

To go back to the beginning of this talk, it is easy to see the many advantages for us all. Those who have really thought on this subject recognize that it must be mutual. But when we attempt to reach this promised land we find as many obstacles as Moses did. The solution will come along economic lines and will eventually take care of itself by the survival of the fittest, which is not saying that the contractors shall devour the jobbers or contrarywise. It does say that each will find his proper place much quicker through co-operation than through strife, that we are made for each other, and instead of many offensive alliances with others we should have one defensive alliance for our mutual benefit. Meanwhile, the man who goes with his times, who is able and active and earnest, and who endures, can and will make money in the business of electrical construction.

W. J. Flannery, President of Baltimore Electrical Supply Co., Baltimore, Md., on Maintaining a Retail Price on Current Consuming Devices.

In reply to the question, "Can a Retail Price be Established and Maintained on Current Consuming Devices," the answer unequivocally is "Yes," and in the interest of not alone the central station, contractor, dealer and job-

ber, but the consumer as well. Unfortunately, in the electric field, particularly in the South, there does not exist the requisite conditions so absolutely essential for the permanent and rapid advancement of the general use of electricity and the proper knowledge of the many applications of same, its advantages and economy, and how much we are in these modern times depending upon it. As a matter of fact it is remarkable, how limited the uses to which electricity can be applied are considered which condition, to a very great extent, is brought about by the fact that it is not recognized that all engaged in the electrical business are depending upon one another and only by the broadest co-operation, can the desired results be accomplished.

There is a tendency on the part of a number of central stations to adopt certain makes of current consuming devices and endeavor to create a demand for same without taking into consideration whether the manufacturers of such goods are willing to dispose of same on a basis whereby contractors, dealers, and jobbers could handle them and in conjunction with the lighting company aggressively develop new business and the use of such goods. In most instances, the central stations wish to purchase at a lower price than the manufacturers will agree to sell any other class of trade, making it therefore obligatory for those in the jobbing business and handling of electrical apparatus, to purchase competitive goods which they can offer to the consumer at about the same price as central stations, if a call is made for such articles. They, however, do so only through necessity and not with the desire to promote the more general use of electricity, and it is undoubtedly true that the trade to a very great extent discourages more than it recommends the use of such articles and without considering that the object of the central station is to increase its load. Naturally they feel that the central station is unjustly and without any occasion for so doing, attempting to usurp the business which properly belong to the contractor, dealer and jobber.

If the central stations would get together with the electrical concerns who sell and carry in stock current consuming devices, fully setting before them their intention of only increasing the peak load, and not to prevent the trade from making a profit on the sale of electrical goods, a plan could easily be devised, whereby all could practically sell all types and makes of such goods on a basis which would insure a profit commensurate with the efforts put forth. Further, by assisting the consumer in selection of various articles, explaining their use, giving exactly what is best adapted for their requirements, etc. etc., unquestionably a greater demand could be created which would undoubtedly exert a powerful influence in developing and stimulating the demand for electrical appliances.

The function of a central station, is to dispose of as large amount of current as possible, and make a profit on the transmission of same. The contractor, dealer and jobber certainly must likewise be considered to have some place in the electrical field, for how could they be expected to make a legitimate profit excepting on the sale of current consuming devices, which also in a general and broad sense means as well, the installation of wires for the conveying of electricity.

We are not working close enough together for our mutual benefit. It is now conceded, that co-operation means success, without it little can be hoped for. The selling of energy is a business in itself, electrical wiring and contracting another, while the dealer and jobber have their individual field. There is an opportunity for each in his own sphere, and by not enroaching upon the duties of another, but by using best endeavors and well directed efforts to boost the adoption of electricity for all purposes, means satisfaction to the consumer, a better understanding between the various branches of the electrical business and a healthy and profitable growth for all. It is certainly worth a trial with conditions thoroughly understood by all to determine if "All Together, All the Time, for Everything Electrical," will not be a more successful method to increase the off peak load of central stations, not only to their satisfaction, but also the consumer, contractor, dealer, and jobber.

F. L. DeMarco, President DeMarco-Fulford Co., Engineers and Sales Agents, Atlanta, Ga. Vital Suggestions on Why the Central Station Should Establish and Maintain a Retail Price on Current Consuming Devices.

The comments that appeared in the December 1911 number of Southern Electrician on "The Central Station, the Contractor, and the Manufacturer" offer a wide field of discussion. The existing deplorable conditions in the electrical supply line are appalling. The central station is in business for the purpose of generating and distributing electrical energy, but this does not mean that it has no right to handle current consuming devices, provided it does not offer same at a reduced price to the consumer.

The contractor, is in an indirect way a solicitor of business for the central station, and he should receive every protection the central station can possibly offer him. It should be the duty of the central station to encourage him and offer every inducement to keep him in business, because his solicitations for jobs mean more current for the station to distribute. It is sad to say, but in various ways, the central station will often offer free wiring and big reductions in prices on apparatus in order to create new business. Through a careful study of human nature, it has been found that "something for nothing" attracts the average person even though it is costly in the end, and this has been one reason for the demoralizing methods now employed by many central stations, which make it impossible for the manufacturer and dealer to establish and maintain a retail price on current consuming devices.

Co-operation must not be overlooked as it is the solid foundation, and only method by which a business can be properly and successfully conducted. The methods of many central stations are far from any form of co-operation. It seems that there is a constant cry in the majority of our cities for lower rates. The central station cannot handle electrical supplies without some expense and by deducting all or a large part of the profits on same, it goes without saying, that some part of the business must be taxed with this expense, and it is natural to believe that this expense must be charged to the cost of generating electrical energy.

If anybody has anything to "give way," let it be their own product and not something that has to be bought. Therefore, if the central station is desirous of "giving something for nothing" as an inducement to promote business, it seems the first and best thought would be to offer a reduction in price of current, which should concern no one to the extent of raising a complaint, provided there is no discrimination in this method. The furnishing of supplies at cost is a detriment to the central station and the three interests mentioned above, and instead of show-

ing an inclination to promote co-operation, it shows more of a tendency to abolish those interests which the central station should regard as its best friends.

Emerson Electric Mfg. Co., St. Louis, Mo., on Maintaining a Retail Schedule.

In regard to the question, why fan manufacturers sell fans to central stations who resell them to the user at cost or practically cost, shutting the deal out of a profit? or in other words, "Can a Retail Schedule on Fan Motors be Successfully Maintained?" the Emerson Electric Manufacturing Company, of St. Louis Mo., has expressed the following answer: The experience of the Emerson Company is conclusive evidence that it is wholly impracticable to maintain any uniform retail schedule throughout the country on such a seasonable article as fan motors. It is easy enough for a manufacturer to adopt a resale schedule and print retail prices in his contracts with the trade, but it is another thing to see that they are maintained by every retailer selling fans.

In the first place a retail price established for one section might easily prove very unsatisfactory to dealers and contractors in another part of the country. A southern dealer selling several hundred fans each season might well be satisfied with a comparatively low retail price, which would not carry sufficient profit to the northern contractor, selling only one-quarter as many fans, to interest him in pushing the business.

Again if the retail price is violated by one dealer or central station, there is no practicable way for the jobber or manufacturer to afford any real relief to the other retailers on account of the shortness of the fans season. In a normal season, fan motors are selling actively for a period of only about sixty days, considering retail business. In many sections the active season is of considerably shorter duration. By the time price-cutting becomes serious, complaints are received, investigated and substantiated, and suitable action can be taken, the season is over, the damage has been done and every one has lost interest in the matter for another ten months.

There are many other equally important factors in the fan motor situation which have forced the management of the Emerson Company to the conclusion that retail prices on fans should be decided in each locality, after taking into consideration all local conditions, freight rates.

No retail price schedules were published in Emerson and Trojan 1911 fan contracts for these reasons, and the plan of leaving retail prices to be decided by each dealer has apparently met with the approval of the majority of dealers as well as jobbers.

As the Emerson Company sells no apparatus at retail, the profits of the Emerson Company are not directly affected, one way or another, but the management of the company advocates very strongly the procuring of retail prices which carry an adequate profit to the retailer. It is futile to hope to increase the sales of fans materially by improper merchandising methods, such as selling at cost, and central stations following that policy are certain to regret it at some later time.

Meanwhile, if some lighting companies insist on following the plan of selling fans without a proper retail profit, the dealers affected can only devote their attention to some more profitable business and wait for the "light of reason" to break in on the lighting company. Such central stations must sooner or later come to a realization that the active co-operation of all the electrical interests in the community is of considerably more value and will actually result in selling more fans than any policy which eliminates such co-operation.

J. F. Pierce, of Pierce Bros., Tampa, Fla., on Maintaining Retail Prices on Current Consuming Devices.

With reference to central stations maintaining retail prices on current consuming devices, it is our opinion, viewed not only from the standpoint of a dealer but as a business proposition, that a reasonable profit is necessary to distribute any class of goods.

This applies more especially to a large class of electrical appliances than every day necessities. The usefulness of new devices of any kind must be demonstrated, which involves expense. The dealer is usually in a position to do this at minimum cost if given the opportunity, a privilege that many central stations seem to want to monopolize in so called "current consuming devices." While trying to pose as philanthropists, the really selfish aim of which is so apparent that a ten year old child can readily perceive the object. People with a grain of sense know that central stations cannot afford to give something for nothing any more than the butcher or laundryman, the consumer pays the freight ultimately, in high rates or poor service.

The contractor and dealer is in more direct contact with the people who usually have more or less confidence in his judgment, and often request advice or information; said dealer or contractor being an ordinary human being and having a living to make, feels more kindly disposed to recommend, or aid in a trial of some device if there is some margin for profit in it for him. It is unnecessary to undertake to describe just how he feels about it, if the said device is being sold at or less than cost by the central station. Especially if said dealer has spent time and money in advertising and introducing something that only continued sale would repay, and which the central station had through love of the consumer and pure philanthropy reduced price to their actual invoice cost.

We, personally, feel rather optimistic on this question believing as we do that the real broad guage and more successful central station managers recognize the advantage of co-operation with the contractor, if he is worthy of such consideration. They are doing so in many instances to their mutual advantage as well as the general public, who profit by better service and being kept in touch with the many improvements in electric appliances that are constantly being made. Speaking from 25 years experience in electrical matters, prospects never appeared better.

C. H. Broward, Member of Firm of F. E. Newcomer Co., Electrical Jobbers, Atlanta, Ga. The Relationship Between the Electrical Dealer and Contractor.

All of the branches of the electrical industry will certainly unite in commending your efforts to promote more harmonious relation between the several branches, and the discussions in your paper will undoubtedly do much toward bringing this about. Unity of purpose should be the key note of these discussions as well as of our daily activities. The electrical industry is so varied and yet so closely linked together in its several branches that anything that effects one department effects them all, and it is essential that all branches work in sympathy, and try to build up business rather than operate independently and tear down.

Naturally, manufacturers, dealers, contractors and central stations see the various problems from different and sometimes opposite viewpoints, but in general the problems concerning them all are those which arise when their practical activities overlap, and these considerations vary with local conditions. The fundamental problem of the manufacturer is to dispose of his products, that of the dealer to distribute supplies to consumer and contractor. The contractor in turn sells his material and work to the consumer, and the central stations furnish the current for operating the various appliances. The manufacturer frequently feels that the dealer has not pushed the sale of appliances to the consumer as hard as he should, either directly or through the contractors, and this accordingly encourages the central stations to sell current consuming devices, and sometimes solicit consumers business direct. With the manufacturers and central stations selling appliances below regular price instead of co-operating with the dealer, the latter cannot be expected to push the sales when his profit is not sufficient to justify same.

Ordinarily there is no good reason why dealer and contractor should not work hand and hand, but the keen competition existing among contractors, especially the small ones, frequently leads them to sell appliances at cost in order to secure the contract for installing and wiring. This naturally leads them to claim that there is no profit to them in soliciting business in such appliances as fans, fixtures, etc., and many a dealer has ultimately become a contractor also because of the necessity for installing the fixtures, etc., sold by him. Consequently the contractor is not disposed to favor the dealer under these circumstances, and goes direct to the manufacturer for his supplies. In cases like this it would be much better for the dealer to sublet the installing to the contractor even if the sale is the result of direct solicitation by the dealer. It would also help conditions generally if the manufacturer would refer the contractor to the nearest dealer handling his products and in this way build up a system of co-operation and good feeling between the contractor and dealer.

General business conditions are probably worse among contractors than any other branch in the industry due to the greater relative number of concerns, and to the lack of business training and knowledge by a large number of them. The better class of contractors would be benefitted greatly if they would form a local association, meet occasionally to discuss their own peculiar problems and compare notes, experiences and outline plans for protecting themselves from the unscrupulous customer, who tells each in turn that his bid is higher than his competitors' in order to get reductions.

The dealers face the same problems as the contractors regarding the untruthful statements relative to competitive bids, and unfortunately the contractors themselves frequently practice this themselves upon the dealers. The remedy here is the same as with the contractors, namely, organize.

Central stations, in their eagerness to sell more current are more and more taking up the sale of current consuming devices, and from time to time have engaged in house wiring at so-called "cost" in order to get new business. Their energy in this direction, as far as creating more business, is commendable, but they should not sell either appliances or do wiring at less than regular price. In fact, it would be better for all concerned if they would sell appliances through local dealers, and sublet all wiring to local contractors. Central stations are just beginning to appreciate the extent of the influence that local contractors and dealers have in deciding a prospective customer for or against central station service as compared with isolated plants. A customer who considers such an alternative is nearly always large enough to be a very desirable one, and a few such customers would be of much greater benefit to the service company than the extra miscellaneous appliances it could sell in a long time by lowering the price, to say nothing of the relative cost of securing each class of business. The good will of dealers and contractors along this line will also be helpful in keeping down gasoline power and lighting competition and making it easier for a solicitor to secure new contracts. Each branch in its eagerness to secure new business is apt to enter the field of another which invariably causes friction and distrust and tends to drive the various branches farther apart, instead of bringing them together.

Another problem of vital interest to all concerned is that of securing a better price for all material sold whether it be appliances, service, or work, and it is only by organizing that better average prices and more stable business conditions can be obtained.

Convention of Electrical Supply Jobbers.

The spring convention of the Electrical Supply Jobbers' Association, which met this year at Cleveland, O., February 13 to 15, ended with the same satisfied feeling in regard to accomplishments as at other conventions of this association. There was a large attendance of both jobbers and manufacturers, and all entered the work of the meetings. The sessions were in the main devoted to discussions of subjects of an educational nature for the benefit of the jobbers interests. Plans were discussed for a closer cooperation between supply men and manufacturers. The entertainment provided was a feature of the meeting, and in regard to it Mr. N. H. Boynton, Manager of the Department of Publicity of the National Electric Lamp Association of Cleveland, Ohio, has the following to say:

"I think that the jobbers who met in convention at Cleveland, are all agreed that no city ever entertained them more royally. In fact any city to surpass the excellent work which was accomplished in Cleveland would have to ask Mr. Cudmore to give more than three days a week for three months to the entertainment feature of the convention. Personally, I don't believe that a more successful convention could have been held; that is, so far as the entertainment features are concerned, than was the local convention. You never saw a voluntary League such as the Cleveland Electrical League, buckle down to any work so faithfully and consistently as did the Cleveland League. There were working committees which had a total of 35 members. So far as I know every one of the 35 were working.

The rejuvenation was a big success even though it was the first rejuvenation that Cleveland had had for over a year. Sixty-two candidates were taken into the Jovian Order, and with the aid of the Pittsburgh degree team the rejuvenation was a great success.

The valentine smoker was perfectly appointed, everything came off without a single hitch and almost on the minute appointed.

Fourth Annual Convention of Mississippi Electric Association to be Held at Vicksburg.

The fourth annual convention of the Mississippi Electric Association, a geographical section of the N. E. L. A., will be held at Vicksburg, Miss., May 28, 29 and 30. Through an error the date has been published in other technical papers as May 21 to 23. While this latter date was the one decided upon at the meeting of the executive committee in January, the change was made on account of conflicting with the date of the Arkansas Association Convention, many desiring to attend both conventions.

The following topics have been selected for papers: Mixed and Low Pressure Turbines up to 750 K.W.; Induction meters; Distributing Transformers; Car Construction; Grounding of Secondaries; Coal Hand and Mechanically Fired.

Besides these papers an address will be delivered by General Geo. H. Harris, treasurer of the National Electric Light Association. A committee has been appointed to arrange for a banquet to be held under the auspices of the Association as well as other forms of entertainment. Those who desire further information on the convention should address Mr. A. H. Jones, of McComb, Miss.

Joint Meeting of Meter Committee of N. E. L. A. and A. E. I. C. With Civic Commissions.

Probably the most unique and important meeting in the history of electricity metering was held in Chicago February 26 and 27th, 1912, when the Meter Committees of the Association of Edison Illuminating Companies and the N. E. L. A. met jointly and invited the representatives of all now existing civic governing and controlling commissions and the meter manufactures of this country. It was practically noteworthy not only because it brought together the greatest aggregation of expert meter talent ever assembled but because of the harmony of effort and unity of purpose existing in this many sided conference, and which evidenced itself continually in the frank discussions which were enthusiastically entered into by the Commissions' representatives as well as those of the manufacturers and the public utility companies. The principal order of business was the revision of the Meter Code which was discussed page by page, construction criticism being obtained from the many view points naturally held by those present. In this manner the revised Meter Code when issued should be made to meet the approval and requirements of the Civic Commissions now existing, as well as the manufacturers and member companies, and should also be readily acceptable to all future Commissions for their guidance and authority in framing laws and regulations bearing on modern electricity meter practice.

The committee on meters of the N. E. L. A. held a two day session immediately following the above joint meeting and discussed and revised practically all contributions and material for the Electrical Meterman's Handbook, which they will present in published form at the Seattle Convention. The committee and its guests were enjoyably entertained by the Commonwealth Edison Company throughout its sessions and especially at a dinner given at the University Club and presided over by Chairman O. J. Bushnell, at which Mr. Gilchrist, Mr. Lieb, Mr. Coles, Mr. Abbott and Mr. Rhodes spoke.

Jovian Order at Atlanta Grows.

Another successful rejuvenation of the Sons of Jove was held at Atlanta, March 2, at the Elks' Club under the direction of L. S. Montgomery, Statesman for Georgia, and Southern Manager for the National Metal Molding Co., of Pittsburg, Pa. The rejuvenation was a decided success in every way, in the number of initiates attending, both of local and out of town and in enthusiasm. Nineteen neophytes became Jovians and were initiated into the mysteries of Jovianism by the members of the degree team, whose names follow: Jupiter, Geo. F. Schoen, No. 1745; Neptune, Gadsden E. Russell, No. 2713; Pluto, T. H. McKinney, No. 4473; Vulcan, Carroll B. McGaughey, No. 2870; Mercury, L. S. Montgomery, No. 2711; Hercules, J. P. Coyne, No. 2708; Mars, W. L. Bailey, No. 4447; Apollo, R. H. Park, No. 2712; Avrenim, A. E. Salling, No. 4482; Imps, P. C. Gilham, No. 4463; D. W. Bowie, No. 4449.

Thos. H. Bibber, No. 158, Statesman at Large, of New York City, presided ably as Toast Master, and in his preoration gave a rousing talk on Jovianism, after which he called upon the following to respond to toasts: Wm. Rawson Collier, No. 4458, Atlanta, Ga.; Geo. F. Schoen, No. 1745, Atlanta, Ga.; Wm. H. Smaw, No. 4488, Atlanta, Ga.; H. T. Paiste, No. 502, Philadelphia, Pa.; W. H. Adkins, No. 4445, Atlanta, Ga.; W. B. Wallace, Neophyte, Atlanta, Ga.; N. L. Walker, No. 2950, Statesman for North Carolina (Raleigh); Gadsden Russell, No. 2713, Atlanta, Ga.

In asking these Jovians to respond to toasts, Brother Bibber called upon them to give ideas and suggestions on "Co-operation," the general subject for the evening.

Resuscitation from Electric Shock.

The Commission on Resuscitation from Electric Shock recently organized upon the initiative of the National Electric Light Association, has for a purpose the study of electric shock and the preparation of a set of rules for first aid in case of electrical accident. The commission is composed of members of the American Medical Association, National Electric Light Association and American Institute of Electrical Engineers, as follows:

Nominated by the American Medical Association: Dr. W. B. Cannon, professor of physiology, Harvard University, chairman; Dr. George W. Crile, professor of surgery, Western Reserve University; Dr. Yandell Henderson, professor of physiology, Yale University; Dr. S. J. Meltzer, Rockfeller Institute for Medical Research, New York; Mr. W. D. Weaver, editor *Electrical World*, secretary. *Nominated by National Electric Light Association*: Dr. E. A. Spitzka, professor of general anatomy, Jefferson Medical College; Mr. W. C. L. Eglin, electrical engineer Philadelphia Electric Company. *Nominated by American Institute of Electrical Engineers*: Dr. Elihu Thomson, electrician, General Electric Company; Dr. A. E. Kennelly, professor of engineering, Harvard University.

At the last meeting in New York City the medical members of the commission unanimously advocated the Schaefer, or prone, method as the best means in the hands of layman for maintaining respiration in victims of electric shock, and the commission formally voted to recommend this method. A chart is now being prepared which will give details of first aid in cases of electric accidents and will describe methods of applying artificial respiration.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

FACTORS IN WHITE WAY SYSTEMS.

Editor Southern Electrician:

(285) In regard to the design and installation of white way systems, kindly publish material from those having been connected with such systems covering the following features: What system of lamps and wiring is best suited, series or multiple, at the decorative post? What should be the proper wattage for 5 lamps standards and three lamp standards and give the spacing for each? For a 5 lamp standard using a 100 watt lamp in upper globe and 4-sixty watt lamps in the lower globes hanging pendant, what should be the proper spacing for a 50, 60 and 80-foot street? If there is some formula for deriving this spacing from the desired intensity of illumination on the street, please give it. What is the general opinion as to best arrangement of globes, upright or inverted? What should be the globe specifications? C. H. T.

TROUBLE WITH GENERATOR.

Editor Southern Electrician:

(286) The writer has two generators connected as shown, Figs. 1 and 2 of the illustration, as *A* and *B*. They operate satisfactorily together, but when machine *B* is used alone on a motor circuit, its voltage drops from 110 to 50 degrees. On the lighting circuit it works all right. The motor circuit consists of a 25 horse power motor connected to operate a scenic railway. Generator *A* is rated at 120 kw., 110 volts; *B* at 50 kw., 220 volts, with fields divided. Both have four poles.

I have tried various connections for operating machine *B* as shown in Figs. 3 and 4. With connections as in Fig. 3, the voltage drops as the load increases. With connections as in Fig. 4, it operates well on steady load. With the connections to the upper field reversed from those shown, the machine will not generate. Please give diagram and directions for proper connections and explain action with various connections shown here.

Will a 220 volt generator with field divided for 110 volt operation, work satisfactorily when the armature is changed to satisfy the requirements also? K. W. HILL.

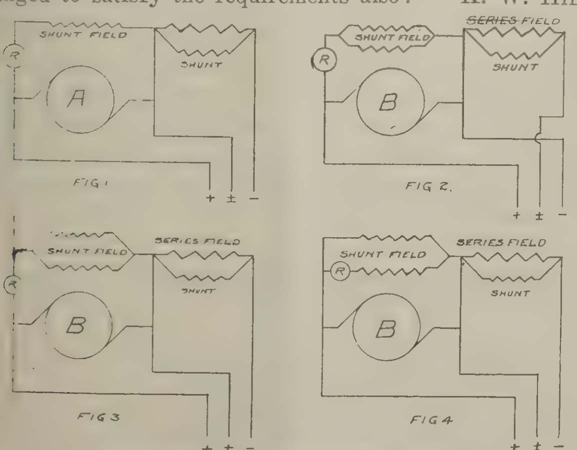


DIAGRAM OF CONNECTIONS USED.

OPERATION OF A 3 PHASE GENERATOR AND CONNECTIONS TO A WATER WHEEL.

Editor Southern Electrician:

(287) The writer has recently installed in his power station a 3 phase, 150 K. V. A. generator replacing a 90 K. W., two-phase Warren machine. The distribution system with the old generator was a two-phase, three wire, so that the change was easily made to a three phase system. The three ammeters now in use each show a line current of 13.6 amperes at 2300 volts or a load of 30 K. W. which was about the same load as was carried by the old two-phase machine. I would like to know if the water wheel now connected to the 3-phase generator is loaded any more than when operating the two-phase machine and delivering the same K. W. at the switchboard. If so how much is the additional load and what causes it?

At present our water wheel is belted to the generator, the nozzle being about seven feet below the generator pulley. During day time and after midnight there is a small load and the belt whips considerably. I have thought of raising the water wheel and connecting direct to generator. If this should be done, about how much power would be lost at the water wheel when operating the generator at 30 K. W. load. How would this loss of power due to loss of 7 feet head compare with friction and slippage loss with the belt on such short centers. Would it be advisable to put in a shaft with worm or herringbone gears? Which method would make the change cost least?

When troubled with mush ice at the bulkhead, I have made connections from one phase to the screen forming a motor rheostat. When this was done the machine was carrying no load. Can there be any injury done the generator from this practice? GEO. BROX.

COST OF INSTALLING UNDERGROUND POWER CONDUCTORS.

Editor Southern Electrician:

(288. Can you furnish me cost data on the installation of underground power conductors? I desire the data divided so to show, (1) cost of conductor, (2) conduit or duct, (3) all other material, (4) labor. Perhaps some of your readers have formulated such data, and can submit same for publication. T. A. B.

CURVES SHOWING CENTRAL STATION EQUIPMENT COSTS.

Editor Southern Electrician:

(289) Is it possible to secure from your readers the following information? A curve showing the variation in cost per K. W. in dollars for A. C. generators both turbo and water wheel type. A curve showing investment in exciters, switchboard and auxiliary electrical station equipment for varying sized stations, 100 to 10,000 K. W. capacity. A curve showing cost per mile of three-phase overhead distribution system for above stations. A curve showing the estimated K. W. capacity per capita to serve towns under 15,000 with light and power. If actual curves

cannot be furnished give curves based upon theoretical considerations showing their general direction. C. A. S.

VOLTAGES FOR INDUCTION MOTORS.

Editor Southern Electrician:

(290) The writer would like to know the reasons for such a variation in operating voltages for induction motors below 25 H. P., namely for operation on 110, 220, 440, 550, etc. In other words, why is it not possible to adopt a standard voltage for all motors up to 20 H. P. Such as 110 or 220 and 550 for sizes up to 50 H. P. with 2,200 the voltage above this size? G. W. B.

Transformer Core Losses, Ans. Ques. No. 258.

Editor Southern Electrician:

Transformer core losses consist of two components, the loss due to hysteresis and the loss due to the eddy currents in the iron core. The equation expressing the first loss that due to hysteresis is,

$$Ph = [Kh\, f\, V\, B^{1.6}(max)]/10^7 \ldots\ldots\ldots (1)$$

Where Ph is the power in Watts, Kh the hysteresis coefficient, f the frequency in cycles, V the volume of iron in cubic centimeters and B(max) the maximum flux density per square centimeter.

The equation for the eddy current loss is,

$$Pe = [Ke(t\, f\, B(max)^2 V]/10^{11} \ldots\ldots\ldots (2)$$

where Pe is the power in watts, Ke the coefficient of eddy current loss, t the thickness of laminations in cubic centimeters and B(max) and V the same as in equation (1).

The fundamental formula for the transformer is, $E = [4.45\, A\, Bmax\, f\, N]/10^8$.

Where E is the impressed effective E. M. F., A the area of the core and *N* the number of turns on the primary. In the following discussion a transformer of a given design is assumed and we shall try to show what occurs when the voltage and frequency are varied. The following terms depend upon the design of the transformer and consequently are constant in value for any one transformer; Kh, V, Ke, t, A and N. We will then substitute the constants G, H and M for the above terms in the three equations as follow; $Ph = G\, f\, B^{1.6}(max)$; $Ph = H\, f^2 B^2 max$ and $E = MBmax\, f$ or $MBmax = E/f$.

From these equations it is readily seen that the hysteresis loss is proportional to $f\, B^{1.6}max$ and that Bmax varies as E/f. Therefore Ph varies as $f(E/f)^{1.6}$ or $E^{1.6}/f^{0.6}$. Then if f the frequency is constant and E the impressed voltage is increased Ph the hysteresis loss is increased. If the voltage is decreased the loss due to hystersis is lessened. On the other hand if E is held constant and f varied, it is seen that Ph varies directly as the frequency. Thus the hysteresis loss can be held constant if the both E and f are changed so that the ratio, $(E^{1.6}/f^{0.6})$ is held a constant.

The eddy current loss varies as f^2B^2max from the above simplified equations. Bmax varies as E/f, therefore Pe varies as $f^2(E/f)^2$ or as E^2. It is thus seen that the eddy current loss is independent of the frequency but varies directly as the square of the impressed voltage.

The total core losses are therefore,

$$Pe + Ph = DE^2 + F(E^{1.6}/f^{0.6})$$

where D and F are constants. Then,

$$Pe + Ph = [DE^2 f^{0.6} + FE^{1.6}]/f^{0.6} \ldots\ldots\ldots (3)$$

From this it is seen that if the ratio of the right hand member of equation (3) is held constant through the various charges in voltage and frequency, the total core losses will also be constant for all changes.

The capacity of a transformer is increased if the primary voltage is increased. The power is proportional to the product of the current and voltage.

The wire in the coils of the transformer is of such size that it will carry the normal full-load current without undue heating, and will carry this current, of course, at any voltage without overheating; therefore, it can readily be seen that increasing the voltage increases the capacity of the transformer, not in direct proportion, however, on account of the increased core losses.

R. E. HENDRICKS.

Transformer Core Losses, Ans. Ques. No. 258.

Editor Southern Electrician:

The core losses in a transformer are made up of what is known as a hysteresis loss and an eddy current loss. There is a mathematical expression for each of these losses however they are some what complicated and are not necessary for the explanation B. H. D., requires. If these equations are required a discussion will be found in all standard works on Electrical Engineering.

In modern commercial transformers the core losses at 60 cycles are made up of about 75 per cent hysteresis, and 25 per cent eddy loss, at 133 cycles it is about 60 per cent hysteresis and 40 per cent eddy current loss. The hysteresis loss is practically independent of the load and kept as low as possible by using the best possible iron and working it at rather low magnitization since the hysteresis loss increases very rapidly as the iron is more strongly magnitized. This may be brought about by using the transformer on a circuit of the same voltage but a higher frequency. In usual practices the two losses are lumped together and spoken of as one loss, the core loss.

Various tests have shown that for a frequency higher than that for which the transformer is designed, the core loss is less, for a lower frequency, the core loss is greater and the transformer will heat up more unless operated at a lower voltage and a reduced output. For the same core loss and same temperature rise, the voltage must be reduced with a lower frequency and can be increased with a higher frequency. This is due to the fact that the capacity depends upon the volt amperes, so that for low frequencies on the same voltage to get the same capacity means a larger transformer.

It must be remembered also that the core loss is dependent upon the wave form of the impressed emf, a peaked wave giving a somewhat lower loss than a flat wave. The magnitude of the core loss also depends upon the temperature of the iron. In commercial transformers, a rise in temperature of 40 degrees centigrade will decrease the core loss from 5 to 10 per cent. Thus an accurate statement of core losses requires that the conditions of temperature and wave shape be specified. H. F. BOYLE.

Condensing Plant vs. Non-Condensing, Ans. Ques. No. 272.

Editor Southern Electrician:

In regard to installing a condenser in the case mentioned by P. H. T., he has failed to give enough data to solve the problem for his particular case. The additional data will be assumed, therefore, and the case figured out

to show the course of reasoning. We will assume an average feed water temperature of 65° F. and that one pound of coal will evaporate 8.5 pounds of water from feed water at 105° to steam at 150 lbs. gage.

TURBINE NON-CONDENSING.

The weight of water 1 lb. coal will evaporate from 210° F. to steam at 150 lbs. gage, is obtained from the following formula:

lbs of water from 210° F. = (8.5 × B. T. U's. put into 1 lb. water at 105° F. to steam at 150 lbs. gage) ÷ (B. T. U.'s put into 1 lb. water at 210° F. to steam at 150 lbs. gage.

B. T. U.'s in water at 105° F. = 105 — 32 = 73 B. T. U.'s.

The heat represented by one lb. of steam at (150 lbs. gage + 14.7 lbs.) = 1193.6 B. T. U.'s.

Therefore the heat put into 1 lb of water at 105° F. to steam at 150 lbs. gage = 1193.6 — 73 = 1120.6 B. T. U.'s.

B. T. U.'s in water at 210° F. = (210 — 32) = 178 B. T. U.'s.

Therefore heat put into 1 lb. of water at 210° F. to steam at 150 lbs. gage = 1193.6 — 178 = 1015.6 B. T. U.'s.

Substituting in the formula above, lbs. of water evaporated by one lb. coal from water at 210° = (8.5 × 1120.6) / 1015.6 ÷ 9.4 lbs.

With turbine using 38 lbs. steam per kw. hr., the lbs. water supplied per hr. = 38 × 2000 = 76,000 lbs.

Thus lbs. coal per hr. = 76000/9.4 = 8100 lbs.

With coal at $3 per ton and a working day of 10 hours, cost of coal per day = (8100 × 10 × 3)/2000 = $121.50.

The cost of water per day at 13⅓ cents per 8300 pounds = (76000 × .133 × 10)/8300 = $12.20 per day.

Thus the total cost of coal and water for running non-condensing the 225 days = ($121.5 + $12.20) × 225 = $30,000.

RUNNING CONDENSING FOR 225 DAYS.

For operating condensing we will not determine the size of condenser and pumps, but assume the following sizes and costs which will be found to correspond with practice:

One surface condenser	5000 sq. ft.	$6250
Circulating pump and engine	20.4 H. P.	705
Air Pump	9.0 H. P.	1250
Condenser steam pump	2.0 H. P.	100
	Total	$8305

Interest and depreciation will be taken at 20%. The steam used per kw. hr. condensing will be taken at 18.8 lbs. all water being returned at a hot well at 105° F. The same feed water heater as with non-condensing can be used. The auxiliaries are allowed 30 lbs. steam per H. P., but only about 6 lbs. of this is chargeable to the engines, as the remainder of the heat is returned to the hot well.

Then, cost of coal for turbine condensing, = (18.8 × 2000 × 10)/8.5 = 44200 lbs. per day.

Cost of coal for 31.4 H. P. of auxiliary = (31.4 × 6 × 10)/8.5 = 222 lbs. per day.

Thus (44200 + 222)/2000 = 22.25 tons coal per day.

Cost of coal at $3 per ton = 22.25 × 3 = $66.75 per day.

The water used for auxiliaries = 31.4 × 30 × 10 = 9420 lbs. per day.

Cost of water = (9420 × .133)/8300 = 0.15 per day.

Total cost condensing for 225 days = (66.75 + .15) × 225 = $15,000.

Depreciation and interest on investment = $8305 × 20% = $1665.

Total expenses (coal, water, dep. and inst.) = $15000 + $1665 = $16,665.

Gain with condenser installed = $30,000 — $16,665 = $13,335.

With a total outlay of condenser equipment of $8,305 as assumed, it is plainly seen that this apparatus should be purchased under the conditions stated by P. H. T.

H. P. Baton.

Condensing vs. Non-Condensing. Ans. Ques. No. 272.

Editor Southern Electrician:

In answer to question 272, perhaps the following will be of assistance. The elementary principle of the steam condenser is to absorb the maximum number of heat units from the steam at a minimum of expense for fixed charges. The greatest vacuum obtainable is the factor upon which the choice of apparatus depends. The cost of pumping the condensing water, one of the primary factors of a condenser plant, depends on the amount of heat absorbed by each pound of water in the condenser. Hence, for a minimum pumping cost, the water should leave the condenser at the temperature of the steam entering the condenser.

In selecting a condenser for any given location, the consideration of quality and quantity of cooling water also its temperature at all times of the year, the variation in steam results on the unit for different variations of vacuum and the load conditions of the units are to be considered.

The consideration of water suply is of greatest importance. If the water contains solids or vegetable matter which go to make scale the jet condenser would of course be the proper one to install. If it does not give trouble from this source at the temperature employed in condensers, it is a distinct advantage to use a surface condenser and save the condensation for use in the boiler. With a minimum temperature of condensing water and a high vacuum, that is around 28 inches, it takes from 26 to 30 pounds of water to condense a pound of steam.

If the auxiliaries were steam driven, their steam consumption would be a large factor in the running expense, a question arising, whether it would not very nearly equal the saving on the turbine. There are many things to be taken into consideration in this problem, one of which is the use to which the condensed steam and water could be put. With the price of water so high a cooling tower or some means of cooling the water should be installed. As a matter of fact, P. H. T. will have to figure pretty close to pay interest on investment, depreciation, operating cost, etc., from the saving by running condensing.

Size of Line for D. C. Motor, Ans. Ques. No. 274.

In answer to this question I submit the following formula: C. M. = 21 DI/v.

Where C. M. = Circular mils, area of wire; D = distance, one way current I is to be transmitted; I = current transmitted; v = volts lost in transmission.

A 40 horsepower D. C. motor has approximately 85% efficiency at average load, therefore at 220 volts it will require approximately 145 amperes. Substituting these val-

ues in the formula and assuming a loss of 10 volts in transmission, we have,

CM = (5280 × 21 × 145)/10 = 1,607,760.

This of course does not take into account the 25 per cent excess required by the Underwriters, but this being out doors perhaps it would not be required. Number 2-0 rubber covered wire is rated at 150 amperes so it does not give much leeway for overload. Figuring for drop supposing that 2-0 were used.

v = DI × 21/CM = [(5,280 × 145 × 21/133,079] = 120 volts, or (120 × 145)/746 = 23.3 h. p.

This does not seem to be very economical, so that a larger size should be used, checking it as above.

Since the inquirer desires formulae for determining sizes of wire, perhaps the following will be of assistance:

$V = (DWRB)/EA$ or $V = (LEB)/100$.

$A = (DWRB)/EV$ or $A = (DWB\ 100)/LE^2$.

$C = WT/E$; $L = (DWR\ 100)/E^2A$.

$P = (D^2WRS)/LE^2\ 10{,}000$ or $P = (DSA)/1{,}000{,}000$.

Where, V = Volts drop in line; D = Distance, in feet between two points on transmission line; W = Total power delivered in watts; E = Voltage at receiving end of line; A = Area of wire in circular mils; C = Current in amperes in each wire; L = Loss in line in per cent of W.; P = Total pounds of copper in line; R, S, T, and B, are constants for value of which see table.

For direct currents, R = 21.6., B = 1.00., T = 1.00 and W = CE so that the first two of the above formulae reduce to V = (DC 21.6)/A and A = (DC 21.6)/V.

In a balanced three-wire, two-phase, alternating current system, the current in the middle wire is 1.41 times that in each outside wire, the current in the outside wires being computed from the formula as if the system were a four-wire one. Where the power-factor cannot be accurately determined, it may be assumed to be as follows, for any alternating-current system operating under average conditions: Lighting with no motors 95 per cent; lighting and motors, 85 per cent; motors only, 80 per cent.

The value for B are for wires 18 inches apart, centre to centre, and are sufficiently accurate for all practical purposes, provided that the reactance of the line is not excessive or the line loss unusually high. The true values at 10 per cent line loss; are close enough for all losses less than 10 per cent and are often close enough for losses considerably above 10 per cent, at least for frequencies up to 40 cycles. Where the conductors of a circuit are less than 18 inches apart, the value of B is less than that given in the table, and if they are close together, as with multiple conductor cable, B becomes equal to unity and can be omitted from the formulæ. A. C. D. in question 273 might use the information in this answer. G. I. Morgan.

Testing Wiring Systems. Ans. Ques. No. 276.

Editor Southern Electrician:

Answering question 276, there is no hard and fast rule for testing iron conduit systems of wiring. The best way to locate the trouble therein, is for the man on the ground to sectionize his circuit until he finds the section that the trouble is in, and then test each wire separately for grounds with the magneto. If a ground develops in a long run it is advisable to cut the wire about half way and see which section the trouble is in. Follow this method out until the trouble is located. If a short circuit is suspected, then turn all of the lamps off at the sockets and then if the magneto rings between the separate wires of the circuit, it shows that the wires are crossed, and it will be necessary to follow out the above method of cutting and sectionalizing until the trouble is located. If the lamps burn at double brilliancy it is an indication that circuits are connected up for 220 volts instead of 110, and the proper change should be made at the connecting blocks. If there is a ground on one of the wires within the section that is connected for 220 volts, simply inserting one fuse will cause the lamps to burn at double brilliancy if there is another ground on the same side anywhere else in the system. C. H. Broward.

Tungsten vs. Carbon Lamps. Ans. Ques. No. 278.

Editor Southern Electrician:

Referring to question No. 278 in March issue, I submit the following:

CURRENT CONSUMPTION OF CARBON LAMPS.

For five, 16-candle power lamps, burning 5 hours per day, 30 days per month, 5 x 5 x 30 = 750 lamp hours per month. When each lamp takes 60 watts, 750 x 60 = 45,000 watt hours per month. 45,000 x 12 = 540,000 watt hours per year or 540 K. W. hours.

CURRENT CONSUMPTION OF TUNGSTEN LAMPS.

A 20-watt tungsten lamp would give the same candle power as a 16-candle power carbon lamp, the efficiency of the tungsten being 1.25 watt per candle. Lamp hours 750 per month. 750 x 20 = 15,000 watt hours per month. 15,000 x 12 = 180,000 watt hours per year or 180 K. W. hours.

The life of a tungsten lamp is about 1,000 hours and the candle power is practically constant. The efficiency of a carbon lamp decreases rapidly. If the candle power is to be kept near to 16, the lamps would have to be renewed twice during the year, or the life of a lamp is taken at 600 hours. The tungstens would have to be renewed once during the year. With the cost of carbon lamps about 20 cents each, and cost of tungsten lamps about 50 cents each, the comparison between the two may be shown clearly in the following table:

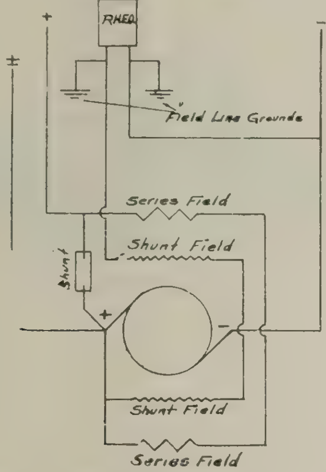
	Tungstens	Carbons
Number of lamps	5	5
Watts per lamp	20	60
Number of hours burned per year....	1,800	1,800
Watt hours per year.................	180,000	540,000
KW. hours per year	180	540
Cost of lamps (10 tungstens, 15 carbons)	$5.00	$3.00

Since the tungsten lamps consume one-third as much current as the carbon lamps, the saving will be considerable. H. A. P. knowing the cost of his current can easily compute it.

Proper Field Connections for Generators, Ans. Ques. No. 283.

Answering question No. 283, I believe Mr. Richmond states the cause of his trouble when he says the field line is grounded. Referring to Fig. 1, it will be noted that if both wires be grounded, current will shunt the rheostat and cause over compounding. Naturally this trouble will grow worse as the load grows greater and the current through the fields increases.

If the ground is of low resistance, the current will, of course, take this path and only a small portion of the total current through the shunt field will pass through the rheostat. The field is then practically across the line without any resistance in series with it. When the load is light and the shunt field is furnishing nearly all of the



CONNECTIONS SHOWING TROUBLE WITH GENERATOR.

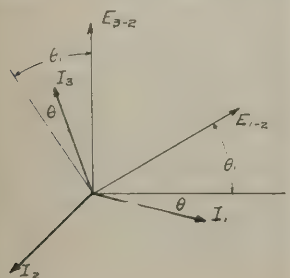
excitation you would not have this trouble, but when the load comes on and the current through both fields increases, the absence of the rheostat resistance in the shunt line causes over magnetization of the poles and a rise in voltage. Since there was no trouble before the field line was grounded I believe it will disappear when the line is cleared of grounds. I believe Mr. Richmond has the shunt across the series field properly connected. J. A. COLLAT.

Proper Watt-Meter Connection, Ans. Ques. No. 279.

Editor Southern Electrician:

When a two-phase system is used for lights and power and the phases loaded as nearly equal as possible, it is known that an unbalancing of both sides of the system exists on an inductive load even though the energy portion of the load be equally divided. In brief, this is due to the fact that the emf of self induction in one side of the system is in phase with the effective emf in the other side, thus distorting the uniform current distribution in both circuits. In the single-phase three-wire and in the three-phase systems the voltage per circuit is always equal for equal loads, but the induction unbalancing of the two-phase, three-wire system is beyond the range of practical operation. The unbalancing effect increases with higher voltages and drops. Such unbalancing as mentioned above is not shown with the two-phase, four-wire system.

In regard to part (2) of this question, a similar case was discussed in the October and November issues of the National Electric Light Association. It was shown mathematically that, no matter what the power factor of a balanced load, when a 3-phase wattmeter has its potential coils interchanged it will indicate zero power, that is, it will stand still or practically so, if properly lagged. When the load is unbalanced, and connections reversed, the meter will register either positive or negative, depending on which term is greater in the expression, referring to Fig. 1,



Connections Correct

Corrections Reversed

$$W = E_{1-2}I_3 \sin \Theta - E_{3-2}I_1 \sin \Theta$$

It is therefore evident that there was an unbalanced condition in Mr. Smith's case and that the product $E_{1-2}\ I_3 \sin \Theta$ was 50% greater than $E_{3-2}I_1 \sin \Theta$. For correct connections, the meter torque is apportioned to,

$$W = E_{1-2}I_1 \cos\ (30° + \Theta) + E_{3-2}I_3 \cos\ (30° - \Theta)$$

H. B. DAVIS.

Wiring for Industrial Plant, Ans. Ques. No. 281.

Editor Southern Electrician:

The general equation for cross-section in circular mils for power and lighting conductors may be written C. M. $= DWK/PE^2$.

Where D = distance in feet one way; E = line voltage at receiving end; P = per cent line loss; W = watts to be delivered; K = a constant having a value that depends upon the system used. For a two-wire D. C. system, K = 2160.

EXAMPLE—What size wire will be required to transmit 7.3 K. W., 400 feet, with 220 volts D. C., and 5% line loss? C. M. $= (400 \times 7300 \times 2160)/(5 \times 220 \times 220 = 26050$.

No. 6 wire has a cross section of 26250 circular mils and is the nearest size to the cross section required.

The following table gives the values of K to be used for the different systems:

VALUES OF K FOR DIFFERENT SYSTEMS.

SYSTEM.	VALUES OF K.				
	Per Cent. Power Factor.				
	100	95	90	85	80
Two-wire D. C.	2160				
Three-wire D. C.	540				
Four-wire D. C.	240				
Single-phase two-wire	2160	2394	2667	2990	3375
Single-phase three-wire	540	598	667	747	844
Single-phase four-wire	240	266	296	332	375
Two-phase four wire	1080	1197	1330	1494	1690
Three-phase three-wire	1080	1197	1330	1494	1690
Three-phase four-wire	360	399	444	498	562

A. L. UTZ.

Thawing Frozen Water Pipes, Ans. Ques. No. 282.

Editor Southern Electrician:

In answer to Question No. 282, allow me to offer the following diagram and explanation. As will be seen from the diagram, the current is taken from an alternating current line, marked "To Primary Line." Interposed in this line should be two cut outs, as designated, not to control the circuit, so much as to guard against mishap, because for any one who performs this test for the first time, the experiment is not without some danger. An ammeter should also be used on the primaries, since with the form of rheostat here shown, the supply of current to the frozen pipes cannot be properly regulated unless some means of current indication is used, for one can not have much of an idea of the current flowing through the water in the barrel without the ammeter. As will be noticed, one side

of the secondary is connected to the water main, since it should be connected back of the frozen portion of the pipes, and it is assumed that as large a pipe as the street main will not be frozen. The handle of the improvised rheostat above the barrel should be made in such a manner that by turning it, the movable fork-shaped electrode will be raised or lowered. In this operation there will be the opportunity for a severe shock, unless guarded against. See that all connection are made tight so that there will be a minimum danger of arcing at contacts. While I have never used direct current from an ordinary 110-220 volt, D. C. system, I see no reason why it should not do as well if available.

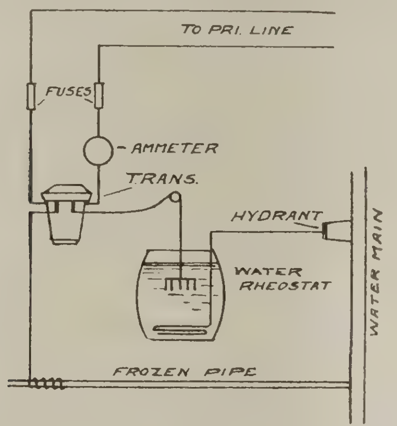


Diagram of Connections for Thawing Water Pipes.

Roy C. Fryer.

Jumping Burned Out Coil in D. C. Machine, Ans. Ques. No. 284.

Editor Southern Electrician:

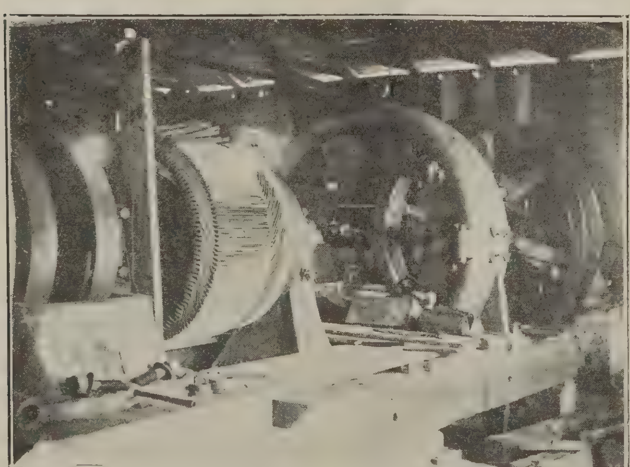
In answer to question 284 I offer the following: Lift the leads of the open coil from the commutator bars to which they are connected and connect the two bars together with a jumper of ample carrying capacity, taking care to have the jumper sufficiently insulated where it passes over other leads, and securely tied down before starting the machine. If the armature has a cover and you do not wish to disturb it, you may bridge out the open coil simply by soldering together the necks of the two bars on each side of the armature between which the open circuit exists. Care must be taken to leave enough solder to carry the required amount of current, or better still, solder a small strip of copper across the bars.

H. R. Long.

New Apparatus and Appliances.

Growth of Chattanooga Armature Works.

One of the oldest successful concerns of its kind in the South today, is the Chattanooga Armature Works, at Chattanooga, Tenn., headed by Mr. Frank Steffner as President. Mr. Steffner is a pioneer in the electrical business, having been engaged in the manufacture of armature and field coils for the past twenty-two years. The company now employs a large corps of electricians and engineers, many recognized as experts in their line. The factory now covers an area of over 6,500 square feet and plans are under-way to erect an additional story. The business has grown steadily and been a natural outcome from a general policy toward customers of "living and let live in matter of prices, with good service and workmanship to supplement this.



Rewinding Generature Armature at Plant of the Galloway Coal Co., Carbon Hill, Ala.

The Chattanooga Armature Works is equipped to manufacture all types of armatures and field coils for both A. C. and D. C. machines and prepared to handle almost any size of work, having worked on turbine equipments as large as 1,000 K. W. It is stated that the company has the best equipped repair shop South of the large Northern cities. The coil trade of the company extends from the district of Columbia to Oklahoma and Iowa, with several of the largest street railways of the South their regular customers for the past eighteen years. A large trade in the mining industries is also enjoyed throughout Kentucky, Alabama and Tennessee. In serving this territory men are kept ready to make repairs on the spot, where it is not desirable to send the work to the factory. Besides the regular work named above the company builds switchboards and taping machines, a 2,000 ampere board being now under construction for the Galloway Coal Co., at Carbon Hill, Ala.

The president of the company Mr. Frank Steffuer mentioned above as a pioneer in electrical work enjoys a wide acquaintanceship throughout the South in the electric railway and mining industries. His son, Mr. S. W. Steffner has also taken up electrical work and since graduating at the Georgia School of Technology has acted as secretary for the company.

Armature and Coil Testing Sets.

The advantage of using alternating-current for testing purposes is well exemplified by the facility with which armatures and individual coils may be tested for open and short circuits, using a testing set such as illustrated herewith. The Westinghouse Electric & Manufacturing Company has found these devices so satisfactory in its own works that it has decided to offer them to the trade with

the belief that they will prove particularly acceptable. The sets here described are divided into two clauses, one for testing the individual coil and one for the completed armature.

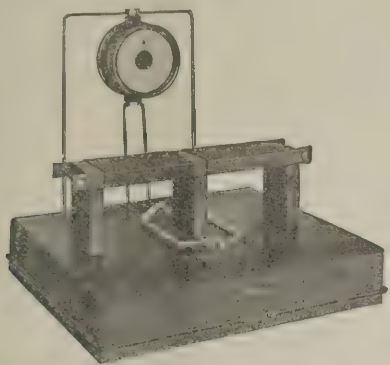


FIG. 1. COIL TESTING SET.

A device for locating faults in armature and field coils before the winding is put in place, is illustrated in Fig. 1. Its use saves further labor on a defective coil. The apparatus consists of an E-shaped electromagnet with a detachable yoke. An exciting coil is on the middle leg of the E. On the back of the E, between the middle leg and either outside leg are wound two small coils so connected that the electromotive forces induced in them oppose each other, and accurately balance so that under normal conditions no current flows.

The field or armature coil to be tested is placed over one of the outer legs of the E and the yoke is omitted. If the tested coil is without fault it has no effect on the flux distribution. If, however, a leak or short circuit exists, a current is induced in the tested coil which so alters the distribution of the flux that more passes through one of the detecting coils than through the other, inducing higher voltage in one than in the other and thus causing a current to flow through them. Such current can be detected by means of a zero-center wattmeter, or by means of a special telephone receiver. To locate a short-circuit in a coil by burning it out, the coil is placed on the middle leg of the E, the detachable yoke put in place as shown in Fig. 1, and the exciting coil connected to the line for a short time. The total weight of this coil-testing set is about 275 pounds. It occupies floor space of 27 inches by 30 inches and is $14\frac{1}{2}$ inches high over all.

FIG. 2. ARMATURE TESTING SET.

The device for testing complete armatures illustrated in Fig. 2, consists of a laminated iron core in which an alternating current magnetic flux is set by connecting the terminals of its exciting coil to a source of alternating current. When either a direct-current or an alternating-current armature of the commutator type is placed against the face of this core, which is shaped to fit an armature, an alternating flux passes through the armature core. If the armature winding is correct, the electromotive forces generated counterbalance each other and no current passes through the winding.

Passing a piece of metal or a knife blade around the commutator, short-circuits in succession each of the coils that have one side under the testing pole. If there is no fault in the winding a decided spark occurs as the knife blade leaves each bar. Absence of spark between two bars indicates either a short-circuit, an open-circuit, or a reversed coil in the windings. A short-circuit or reversal will cause a local current in the coil, which will generate a flux around the slots in which the coil lies. Such a local flux can be detected by running over the surface of the armature a piece of sheet iron held lightly, bringing from one tooth to the next successively. A local flux caused by a short-circuit or reversed connection will attract the piece of iron when it bridges across the slot containing the defective coil. If no such local flux is detected, the fault disclosed by the sparking test is due to an open-circuit. The core is mounted on a stand provided with wheels or on a stationary stand. It is used in vertical position close to the armature. Two sizes are made, one for armatures up to 12 inches in diameter and one for armatures 12 inches or more in diameter.

Victor Electric Iron.

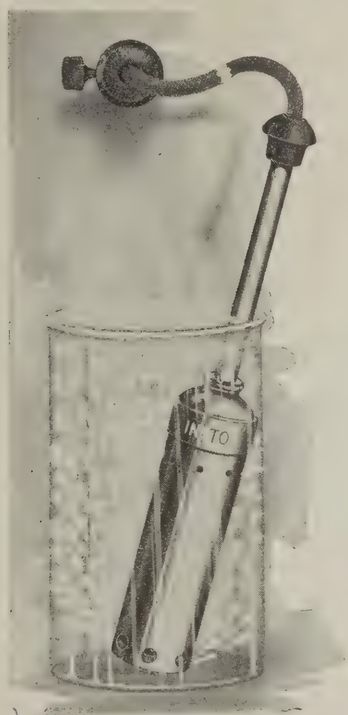
The demand for a medium priced electric iron has caused the Victor Iron Co. of Logansport, Ind., to make an iron retailing at \$3.75. In exterior design the iron is shapely and similar to many others. The heating unit has no core, being of very simple design and having stood severe tests by the maker. The iron weighs $6\frac{1}{4}$ pounds. The iron body is divided in two compartments, the lower one containing the heating element and the upper one an asbestos board which confines the heat to the bottom of

THE VICTOR ELECTRIC IRON.

the iron, leaving the upper part and handle cool. The plug of the iron is made of one solid piece of fiber, non-breakable, the terminals being made in a tapering shape, to fit on corresponding tapering shape pins on the body of the iron. As the terminals become worn or burned, this tapering shape allows them to adjust themselves to the new conditions and thus maintain a perfect contact at all times.

The Insto Electric Water Heater.

The electric water heater and sterilizer shown herewith is manufactured by the Insto Electric Heater Company, of Cincinnati, Ohio. It is designed so that a cord attaches it to an ordinary electric light socket and the heater is said to produce hot water in 2 minutes and boiling water in 4 minutes. It will also boil coffee, tea or milk and is said



Insto Water Heater.

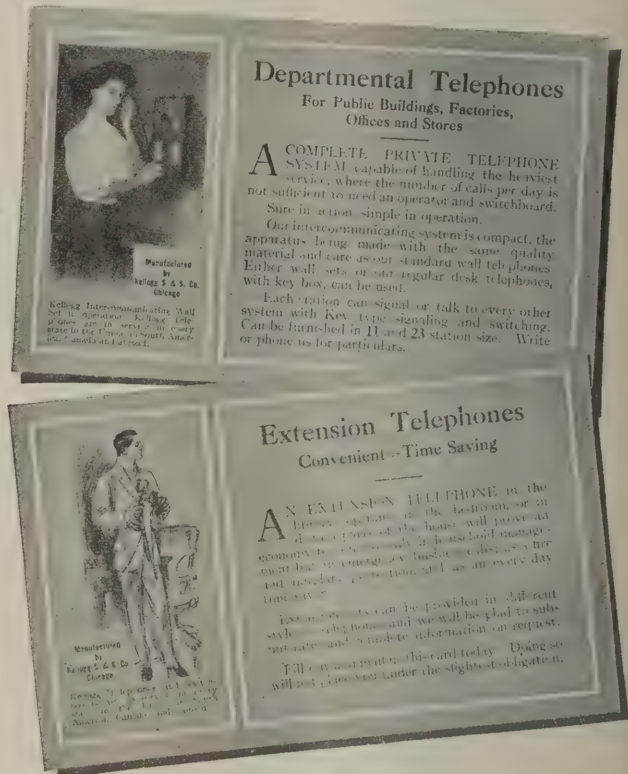
to be handy for poaching and boiling eggs. As a sterilizer its value is also emphasized and in shaving it is useful. The Insto Heater is universal in use, operating on either direct or alternating current at voltages of from 95 to 125. It is referred to as sanitary and safe and can be easily cleaned and a glassy polish maintained by ordinary care.

Plas-Mica—A Soluble Form of Mica.

A soluble form of Mica for repairing commutator insulation placed on the market by the Plas Mica Company, of 26 St. Andrew's Place, Yonkers, N. Y., is known as Plas-Mica. It contains similar ingredients as natural mica, the mineral going through a long process which separates the several constituents, which are united again when the powder and liquid are mixed. The powdered product when mixed with the liquid sets to about the same degree of hardness as natural mica when compressed between the bars of a commutator. When Plas-Mica is applied properly and mixed with the correct amount of liqurd, it is said that it will adhere to the natural mica left between the bars and will not sling out or chip when the commutator is running. Nor does it shrink when setting and will always fill the slot when carefully rammed in when plastic. The hardening action is caused by the chemical combination of the liquid and powder and a set may be effected in a short or long time as occasion requires. Plas-Mica is said to resist oil, acid and water. It has been also heated to a welding heat in a crucible without undergoing any material change in structure. A three-quarter ounce bottle liquid and powders it is claimed will make 15 to 30 ordinary repairs.

Telephone Selling Methods.

The methods of the Kellogg Switchboard and Supply Co., for assisting customers includes not only practical engineering information but advertising assistance. The Company is distributing free to customers two very attractive postal cards that can be used by the operating companies in their campaigns for new subscribers.



These cards, printed in two colors illustrate and describe, in a way appealing to the subscriber, the advantage and economy of extension sets in homes or offices and automatic push button intercommunicating systems for residences, offices, factories and warehouses.

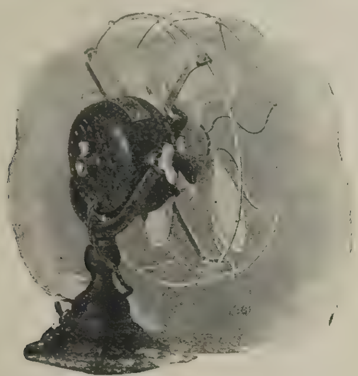
Snap Switch Heat Control.

One of the great problems which manufacturers of electric heating devices have had to solve is how to make heat regulation possible. Many more or less satisfactory devices have been equipped with knife switches which invariably get out of order. The Diamond Electric Company, makers of Delco devices, have adopted a standard three heat snap switch and apply it to practically all of their devices, making control easy and results satisfactory to the user. The Delco three heat iron has this three heat snap switch control, which gives such universal satisfaction to the user.

1912 Models of Electric Fan Motors.

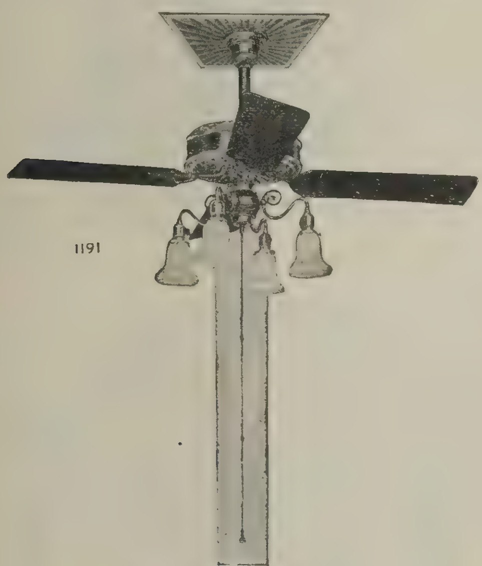
Emerson Fans.

The Emerson Electric Mfg. Co., offers for the 1912 season new types of fans for both direct current and alternating current use. The D. C. type includes 8-inch, 12-inch and 16-inch swivel-trunnion fans, 12-inch and 16-inch oscillators and the popular residence type slow-speed swivel trunnion and oscillating fans for direct current. The line of Emerson fans is accordingly more complete than ever before. Important improvements in alternating-current desk fans enables this company to offer a complete line of three-speed induction desk fans in the swivel-trunnion and oscillating styles.



THE EMERSON DESK AND BRACKET FAN.

Emerson and Trojan ceiling and column fans for A. C. service are the same as offered the trade last season with minor detailed improvements. The Emerson bedstead and elevator 8-inch fan can be furnished this year for direct current as well as alternating and is suited for hotels having isolated plants. The Southern distributor of Emerson fans is the Southern Wesco Supply Co., of Birmingham, Ala.



EMERSON CEILING FAN.

Robbins and Meyer Fans.

The 1912 line of fans offered by the Robbins and Myers Co., of Springfield, Ohio, includes 8, 12 and 16-inch D. C. and A. C. desk and wall bracket types, 12 and 16-inch D. C. and A. C. oscillating fans, 12 and 16-inch D. C. and A. C. exhaust fans, with the usual line of D. C. ceiling fans and the ornamental and plain types of A. C. ceiling fans. The fan motors in each case are designed for all standard voltages and frequencies. Two designs of A. C. oscilating desk fans, models 11 and 14, use a special form of winding which was tried on model 14 last year with success. The winding eliminates the troublesome centrifugal switch and consequent burnout of the starting winding when the switch fails to operate. This winding in connection with the special method of riveting the field punchings eliminates all noise and makes a quiet running fan. Model 11 geared-type oscillator is offered for the second season furnished for both direct and alternating current.

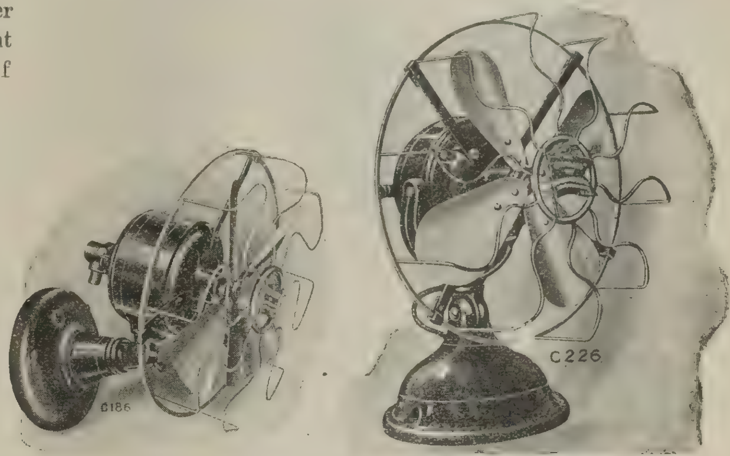


FIG. 1. WALL BRACKET AND DESK FANS.

FIG. 2. A. C. CEILING FAN.

The styles E and F alternating current ceiling fans employ the same type of winding as the A. C. desk fans. The motors are strongly constructed and practically noiseless. The fan blades are mounted on a spider directly beneath the motor which gives benefit of the full sweep.

Western Electric Fans.

The 1912 fans offered by the Westinghouse Electric and Mfg. Co. of Pittsburg, Pa., represent a complete new line with steel frames instead of the usual cast iron construction. This change in design and construction represents unquestionably a great advance in fan-motor construction. The motor frame, the base and the guard arms are made of drawn steel, which combines great strength with minimum weight, the fan motors weighing from 20 to 40 per cent less than cast iron frame motors of same sizes.

A special feature of these fan motors is the swivel-and-hinge joint which connects the motor and the base. By

means of this joint, the fan can be tilted within 105 degrees or rotated 340 degrees in any direction and can be changed from desk to bracket mounting without the use of a trunnion, tools, or an adapter. All 25-30, 50 and 60 cycle fan motors have three speeds and there is a marked difference in the effect of the fan at each speed. The speeds are controlled by a lever in the base of the fan which is firmly held at each running point and does not open the circuit between points.

FIG. 1. MECHANICAL AND AIR OPERATED OSCILLATING AND 8-INCH FANS.

The motors for the drawn steel fans are of new design and have been made very efficient, showing an unusually low current consumption for the amount of air moved. This has been accomplished without sacrificing the air output. The fan blades are the standard design selected after years of trial and generally adopted for fan motor use. They are so shaped as to move the maximum amount of air with minimum noise and least expenditure of power.

Series wound motors are used for 25-30 cycle fan motors on account of their higher efficiencies for this frequency range and also the greater torque than the induction type. Series motors also permit higher speeds on this frequency thus delivering more air. Imported brushes of large area and the very best quality are used thereby insuring an unusually long life.

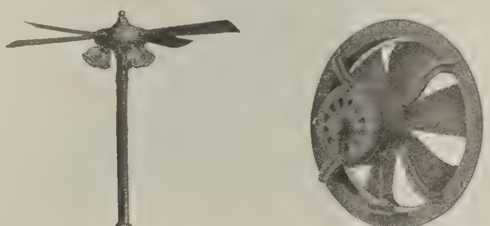


FIG. 2. COLUMN AND EXHAUST FANS.

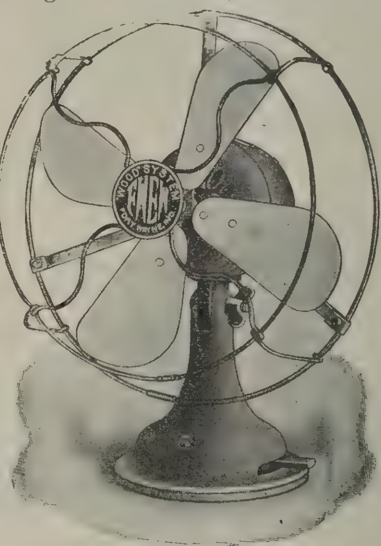
A new line of mechanically- operated oscillating fan motors in drawn steel frames, a further development of the desk and bracket line, will be offered this season. In these fan motors the oscillating mechanism is entirely enclosed; the oscillating movement can be stopped and started while the fan is in motion; the fan can be tilted or changed from desk to bracket mounting without the use of a trunnion or an adapter. Mechanically-operated oscillating fan motors in cast iron frames of the design so successful last season, are again offered. The gears of the oscillating mechanism operate in a closed case packed with grease and require lubrication once a season only. The arc of oscillation can be made 45 degrees or 90 degrees, or the oscillating movement can be stopped altogether if desired.

The air-operated oscillating fan motors offered this year are an improvement over last year's models. The oscillating movement is effected by means of vanes mounted in front of the fan guard; the arc of oscillation can be varied from 30 degrees to 360 degrees, in steps of 30 degrees. The current is carried from the base to the motor through slip rings so that there are no leads to be broken.

The Westinghouse line for 1912 is complete and includes fan motors for every purpose and for every commercial circuit on which fan motors are used. It comprises 8-inch, 12-inch and 16-inch desk-and-bracket, 12 and 16-inch machanically operated oscillating, 12-inch and 16-inch air operating, 12-inch residence, 8-inch telephone booth, long sweep and 32-inch ceiling, counter column and floor column, and 12-inch and 16-inch exhaust or ventilating fan motors.

Fort Wayne Fans.

Few changes have been made in the 1911 fans which the Fort Wayne Electric Works is offering for this season, aside from the usual details brought about through a season's operation in perfecting details already made. The fans offered are designed for all voltages and frequencies. An 8-inch oscillating fan has been added to the line for which a large demand is expected. It is thoroughly



FORT WAYNE 8-INCH A. C. FAN.

practical and of serviceable design. The field of this fan is of the split-phase design, wound with two poles securing a synchronous speed of 3,600 r. p. m. and a full load speed of 2,200 r. p. m. against a full load speed of 1,600 r. p. m. in four-pole windings. The Fort Wayne fan is said to be the only one using the two-pole winding.

The 1912 line includes fixed, oscillating, revolving, desk, bracket, ceiling, counter, column and floor types.

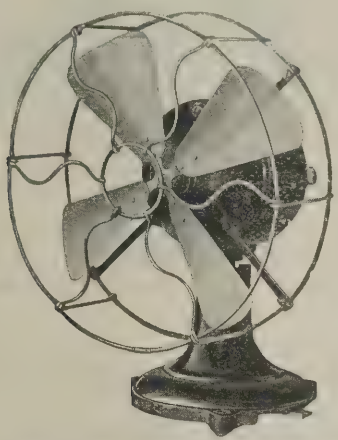
Colonial Fans.

The Colonial Fan and Motor Co., of Warren, Ohio, has this year its usual line of 12-inch and 16-inch universal A. C. and D. C. fans, the former having two distinct speeds and a cut out the variation between the first and second speeds being greater than with last year's designs. The direct current types have three distinct speeds and a cut out An alternating and a direct current 8-inch fan is also offered built similarly to the 12 and 16-inch fans, with universal joint, for desk or bracket use. A change has been made in the oscillating fan making it of the worm gear type and oscillating half as fast as last year's model. These are built in 12 and 16-inch sizes for alternating and direct currents. The line included besides these, direct-current

ornamental type electrolier and direct current plain type ceiling fans with long blades; 8-inch, 12-inch, and 16-inch alternating current universal desk and bracket, and 12-inch and 16-inch alternating current oscillating fans.

Dayton Fans.

The fans offered by the Dayton Fan and Motor Co., of Dayton, Ohio, include direct and alternating current desk and ceiling types. The A. C. fans are of the induction type, the desk style being a four blade and six blade de-



THE DAYTON 1912 LEADER FAN.

sign. The direct current fans differ little from those of last year, the ceiling types having sweeps of 32, 48, and 57 inches and of the single-speed drum armature design. The alternating ceiling fans have a 60-inch sweep with three speeds of 125, 175 and 225 r. p. m.

Kimble A. C. Fans.

To its line of fans for 1912 the Kimble Electric Co., Chicago, has added a 42-inch ventilating fan. This fan is driven by a two-horsepower, single-phase, variable-speed reversible motor. Its maximum speed is 550 revolutions per minute, at which speed, it is claimed, it will move 22,000 cubic feet of air per minute. A distinctive feature of Kimble fans is the fact that the motor is instantly revers-

KIMBLE A. C. VENTILATING FAN.

ible from any speed forward to any speed in the opposite direction, and that the power consumed is at all times in approximate proportion to the speed of operation.

The Kimble fan is built regularly with straight aluminum blades, that the user may realize the full air-moving efficiency, whether he operates the fan for intake or exhaust. Another feature of the Kimble fan is the low starting current that it requires, making it feasible for installation on lighting circuits. For instance, it is claimed that the 36-inch straight-blade fan driven by a one-and-one-half horsepower Kimble motor, moving 17,300 cubic feet of air per minute at 550 revolutions per minute, starts on four amperes, runs full speed on eight amperes, and reverses from full speed forward to full speed backward on nine amperes.

Western Electric Fans.

The additions to the Western Electric Company's line of fans include a 12 and 16-inch desk and bracket fan, 12 and 16-inch mechanically operated oscillating fans, and the 12-inch, six-blade residence-type fans. In these types a drawn-steel frame instead of the ordinary iron frame is used. This feature, which is an innovation in the manufacture of electric fans, possesses several advantages. It

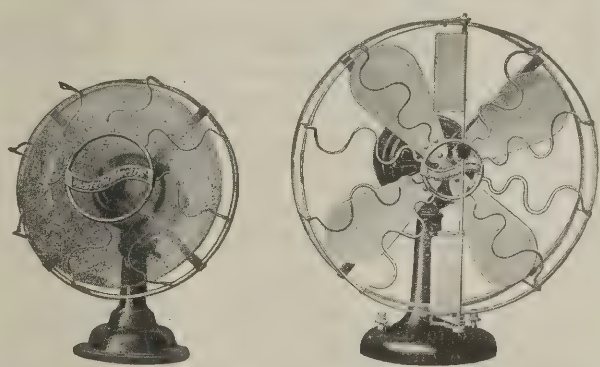


FIG. 1. EIGHT-INCH DESK AND BRACKET AND 16-INCH OSCILLATING FANS.

affords a fan of much greater strength, yet of lighter weight, the drawn-steel fans being from 20 to 40 per cent lighter than iron fans of the same types and sizes. Another advantage possessed by drawn steel over the iron frames is in the finish. The steel frame lends itself to a variety of finishes, such as statuary bronze, mottled copper, polished brass, brushed brass and nickel. The surface of the drawn steel is smooth and lustrous, giving an effect that cannot be obtained in fans of cast-iron frames.

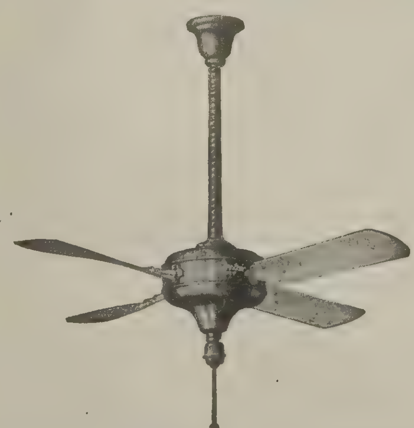
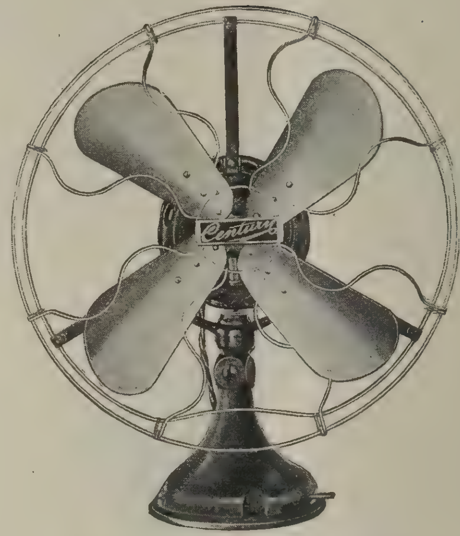


FIG. 2. WESTERN A. C. CEILING FAN.

In addition to the drawn-steel types of fans, the Western Electric Company has also added to its already complete line a new 32-inch alternating current ceiling fan, which is furnished in black enamel, white enamel and mottled copper.

Century Fans.

A complete line of alternating current, split-phase induction type fan motors is announced by the Century Electric Co., of St. Louis, Mo. The line includes the 16-inch desk and wall bracket fan, the 16-inch oscillating desk and wall bracket fan, the 12-inch desk and wall bracket fan, the 58-inch ceiling fan and 58-inch ceiling fan with electrolier. A feature of the desk fans offered this year is the 16-inch oscillating type in which spur gears are used to effect the speed reduction. These gears are operated in a greased pocket; the weight of the fan motor is carried on ball bearings so that the friction loss through the oscillation is reduced to a minimum. When the fan is tilted from a horizontal adjustment throughout it has 120 degrees of oscillation and the air is blown in the same plane.



THE CENTURY A. C. DESK AND BRACKET FAN.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

BLACKROCK. The improvements to the municipal electric light plant are to be made by L. P. Caldwell of Batesville.

BOAZ. The city has made arrangements for the installation of an electric light plant.

CHEROKEE BLUFFS. It is understood that the first development of the Alabama Traction, Light & Power Co., will be at Cherokee Bluffs on the Tallapoosa River, and will consist of an ultimate capacity of 100,000 H. P. The initial development will be sufficient to develop 60,000 H. P. The Coosa River Power site will be near enough to the proposed transmission lines between Cherokee Bluffs and Birmingham, so that it can be connected to it. It is understood further that the Alabama Interstate Power Co., of which Chas. H. Baker is president, of New York City, will undertake the construction work.

CORDOVA. The Cordova Light & Power Co. has been incorporated with a capital stock of $6,000 by E. T. Henden, G. S. Elliott, and J. M. Miller.

DOTHAN. A new lighting system has been authorized and contracts will be soon awarded for the installation.

FORT DEPOSIT. The Little River Power Co. is said to be planning the construction of a dam for its proposed hydro-electric plant on Little River. R. A. Mitchell of Gadsden, Ala., can give other information.

GADSDEN. The Gadsden Car Works will improve its plant at an estimated cost of $20,000. It is understood that an electric light plant is to be installed.

MONTGOMERY. Prices are desired on electric fixtures by R. L. Benick, 416 Washington St., Montgomery, Ala.

ONEONTA. A franchise has been ranted to D. S. Martin and associates for the purpose of constructing and operating an electric light plant.

FLORIDA.

BROOKSVILLE. It is understood that a franchise has been granted to John T. Fuller for the purpose of constructing and operating an electric light system and water works.

DAYTONA BEACH. The Schantz Electric, Ice & Water Co. has secured a franchise to construct an electric light plant.

FORT MYERS. It is understood that the Seminole Power & Ice Co. is contemplating the installation of a 600 H. P. direct connected generating unit and complete condensing system during the next year.

MOUNT DORA. The Eustis Light, Water & Power Co. of Eustis has been granted a franchise for supplying electric energy at this place. It is proposed to connect with the Eustis Trazeres line at Travis.

ST. PETERSBURG. It is understood that on ornamental street lighting system is under consideration for the business district in St. Petersburg. 42 ornamental lamp standards are considered and the system is proposed to cost approximately $2,000.

GEORGIA.

ATLANTA. The Georgia Power Co., now a part of the Georgia Railway & Power Co., contemplates the construction of a net work of interurban electric railways, connecting Macon, Atlanta, Augusta, Columbus, and other cities.

ATLANTA. The papers transferring the Georgia Power Co., the Georgia Railway & Electric Co., and other smaller properties to the newly formed $57,000,000 corporation, the Georgia Railway & Power Co., were delivered on Saturday, March 16th. The Georgia Railway & Electric Co. is the most important factor in the newly organized company, and Mr. P. S. Arkwright, its president, will also be president of the new organization. The officers of the company are as follows: P. S. Arkwright, president; G. W. Brine, vice-president and general manager; W. H. Glenn, vice-president and secretary and Mr. I. S. Mitchell, Jr., treasurer.

ATLANTA. The settlement of light and power rates and other differences between the Georgia Railway & Electric Co. and the city of Atlanta has reached a point where the company has made the following agreement now before the city council for approval. They agree to reduce the light rates from 9 to 7 cents net, reducing the monthly minimum on lights from $2.00 to $1.00, reducing power rates from 5.4 to 4.5 cents net, and reducing the monthly minimum on power from $1.00 to 50 cents per horsepower. The company further agrees to pave 16 feet where car tracks are double in place of the present basis of 11 feet. It also agrees to extend 200 feet of light or power lines for one customer without charge. Although January 1st, 1913, was the date agreed upon when the settlement should become effective if passed by the council, it is now stated that the Georgia Railway & Power Co. will prob-

ably reduce the rates immediately upon completion of the new transmission line leading to and from their new hydro-electric developments.

CARTERSVILLE. A bond issue for the purpose of securing funds for extension to the municipal electric light plant and water works system will be voted upon in the near future.

COLUMBUS. The Columbus Power Co. is planning to erect a transmission line to Newnan by way of West Point and LaGrange. Steel tower line will be constructed.

COVINGTON. The city council has decided to appoint a committee to investigate the feasibility and cost of establishing a municipal electric light plant.

NORTH CAROLINA.

ASHEVILLE. According to reports local interests have planned the erection of a large hydro-electric plant capable of generating $18,000 H. P. on the French Broad River near Newport, Tenn. Surveys are being made and options on sites secured.

BRYSON CITY. The Union Development Co., of which J. W. Adams of Chattanooga, Tenn., is president, has under consideration the construction of a water power electrical plant. The plant will be of sufficient capacity to develop 50,000 H. P. and will cost about $400,000. J. W. Ricky of Masena, N. Y., is chief engineer.

CHARLOTTE. The Highland Park Mfg. Co. desires prices on a 250 K. W., 2300 volt, three-phase, 60-cycle, 450 R. P. M., second hand generator. The generator must be attached for a rope drive.

CHARLOTTE. The Southern Power Co. has awarded a contract for the construction of a third auxiliary steam power plant which will be located near Charlotte. It is understood that this plant will cost approximately $250,000 and will have an output of 10,000 H. P.

LOUISVILLE. It is reported that an electric light plant is under consideration and that N. E. Whitman and others are interested.

MONTREAT. The Mountain Retreat Association desires prices on a 100 H. P. engine and boiler and a 50 K. W. dynamo. Rev. R. C. Anderson is president.

SALISBURY. It is understood that a French syndicate is now taking options on property on the Yadkin River about two miles below the Whitney Reduction Plant near Albemarle for the purpose of developing a hydro-electric power plant. C. M. Armstrong of Troy is representing the syndicate.

SOUTHPORT. The Southport Light & Power Co. has been incorporated with a capital stock of $50,000 by H. K. White, C. N. Taylor and Henry B. O'Hagan.

STATESVILLE. Prices are desired on a 14-12 eight and six H. P. motors for use in farm buildings by J. W. Summers, Route 5, Statesville, N. C.

WHITAKER. Citizens have voted on a bond issue of $10,000 for the establishing of an electric light plant. J. O. Hearne can give other information.

WILLIAMSON. The Williamson Electric Co. has been incorporated with a capital stock of $25,000 and has purchased the electric light plant, franchise, etc., of the former company of which W. C. Manning was president, John W. Manning, secretary.

TENNESSEE.

CAMDEN. Plans are under way for the establishment of an electric light plant. It is understood that the power for operating the plant will be obtained from the planing mills of the J. C. Durdin & Sons.

CHATTANOOGA. The Chattanooga Railway & Light Co. has made a proposition to the retail merchants association offering to furnish electricity to maintain a white way system on Market Street to extend from Sixth Street to the Terminal Station until December, 1914, free of charge. The plans call for the erection of 111 lamp standards, each bearing five lamps. The merchants and property owners along the route will pay for the cost of installation.

HENDERSON. The Priestly & Lloyd Light & Power Co. has been incorporated with a capital stock of $10,000 by C. W. Priestly, T. R. Priestly, J. H. Priestly, and A. C. Lloyd, Jr.

LYNNVILLE. The city is preparing to secure bids for the installation of an electric light plant.

MEMPHIS. Prices are desired on electric fixtures by R. Graham Bostwick, 14 South Main St., Memphis, Tenn.

BOOK REVIEWS.

ELECTRIC DISCHARGES, WAVES AND IMPULSES, AND OTHER TRANSIENTS, by Dr. C. P. Steinmetz. Published by McGraw-Hill Book Co., New York City. 150 pages. Price, $2.00.

This work takes up the subjects mentioned in the title from the standpoints of physical nature and meaning, origin and effects. While it presents a most thorough discussion of all topics, and is similar in many respects to a former work of the same author on "Theory and Calculation of Transient Electric Phenomena and Oscillations," it has been written for the busy engineer who does not care to take up the mathematics included in the former treatment. Many oscillograms of electric discharges, waves and impulses taken on industrial electric circuits give a comprehensive idea of transient phenomena. To the engineer preparing to investigate any of these phenomena this work is invaluable. Nine chapters of the work are devoted to transients, the tenth taking up capacity and inductance of conductors fundamental qualities on which the transient depends.

PERSONALS.

MR. MONTFORD MORRISON, a physicist and investigator along electrical lines, has recently become connected with Atlanta capitalists and organized the Morrison Company. Mr. Morrison's plans for the new company include extensive research work to results in special electrical designs and the development of practical apparatus. In an interview with Mr. Morrison regarding the field to be covered, nature of work and methods to be pursued, he has the following to say: Our company has been organized for the express purpose of rendering a service to consulting engineers, manufacturing firms and private individuals, interested in the development of electrical apparatus, and the securing of opinions on electrical matters, based on careful investigation. In as far as I know, no company is now in existence which aims to cover in an exactly similar way or to any comparable extent, the service of an investigative nature planned by the Morrison Co. In making this statement, I am not prompted by any selfish motives or desire to exaggerate the work laid out but have on the other hand a personal knowledge of the unsatisfactory conditions as now existing and shall in as far as my knowledge in this direction goes try to remedy such. While our company will maintain a well equipped laboratory, its work will not be after the nature of the ordinary testing laboratory, it will reach out further in all directions, furnishing to those interested, technical investigative service, design service, patent investigations and prosecutions, and commercial exploitation.

"The company will maintain an engineering corps, covering all the branches of engineering based upon physics and chemistry. This corps will consist of one specialist engineer with assistants for each branch of engineering, all specialists reporting to the physist who has the personal direction of this corps in charge. It is in this position that I have been selected to act and from which I shall endeavor to carry out the plans of the company as have already been explained."

In addition to the above statement by Mr. Morrison, we might say that the Morrison Company has in the capacity of a physist, one who is able to carry out the work most successfully. Originally Mr. Morrison started in engineering work as a designer, however the large amount of research necessary in perfecting the designs with which he has been connected, has gradually turned him from design to pure physical and electrical investigations. From the standpoint of ability to give physical and electrical problems a mathematical interpretation, he is unusually equipped. During the past ten years he has produced in the neighborhood of 300 designs and has several valuable patents which the company will immediately exploit.

INDUSTRIAL ITEMS.

DOSSERT & COMPANY, of New York report gratifying results in securing new business in the South. In addition to the extensive use of Dossert solderless connectors in the power house wiring of the Yadkin Power Company at Pee Dee, N. C., recent orders for these devices include the following: Transformer connections, Appalachian Power Co., Pulaski, Va., under direction of Viele Blackwell & Buck, engineers; high tension wiring, Oconee development, under direction J. G. White & Co., engineers, Cleveland, Tenn.; switchboard connections and taps from risers, new Busch Hotel, Dallas, Texas, from the Hobson Electric Company, and many others.

THE MORRISON COMPANY of Atlanta, Ga., has recently been incorporated with a capital stock of $50,000, by Montford Morrison, J. L. Prior, R. O. Howard, and J. F. Sprague. This company was organized for the purpose of developing and manufacturing electrical designs. The plans of the company are fully explained under the heading of Montford Morrison, in the personal colums of this issue.

EDWARDS & COMPANY, New York City, has issued a new edition of a catalogue on electrical house goods. This catalogue takes up different types of annunciators, bells and buzzers, fire alarm apparatus, etc., manufactured by the company. The Edwards & Co., is represented in Atlanta by Mr. F. V. L. Smith, at 421 Wesley Bldg., Atlanta, Ga.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

Attachment Plugs, Fuseless.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. "C-H" Edison type, 660 w., 250 v., porcelain cap, composition cap, composition base and cap. Approved Feb. 1, 1912.

Canopy Insulators.

MITCHELL-VANCE COMPANY, 507 West 24th St., New York. "Vance." Fibre ring riveted to fixture canopy giving insulation between canopy edge and wall or ceiling. Approved January 23, 1912.

Conduit Boxes.

BONNELL MFG. CO., Winter and Leonard Sts., Cleveland, Ohio. "Adapti boxes." Outlet boxes for use with rigid conduits of sizes ½ inch to 3 inches inclusive. Approved January 31, 1912.

THOMAS & BETTS CO., 299 Broadway, New York City. "T. & B." Universal Pressed Steel Boxes. "T. & B." "Dead Ground" cast iron boxes for armored cable or flexible steel conduit. Type A, straight electric, type B, combination. Approved January 29, 1912.

PARS & SEYMOUR, INC., Solvay, N. Y., "P. & S." brass conduit box covers, for 3 and 4-inch round conduit boxes. Approved Feb. 1, 1912.

Fixtures.

CHICAGO MINIATURE LAMP WORKS, 2110 South Halsted St., Chicago, Ill. Incandescent lamps in the form of individual letters mounted on porcelain bases having receptacle and plug contacts by means of which letters may be connected in circuit to form words. Each letter takes 1-10 ampere at 110 volts. Approved Feb. 7, 1912.

FEDERAL ELECTRIC CO., 640 West Lake St., Chicago, Ill. "Federal" indoor and outdoor lamp clusters. Approved Feb. 7, 1912.

RUSH BROS., 65 East Lake St., Chicago, Ill. "Rush Faience" ceramic electric fixtures, glazed pottery bases on which are mounted special lamp receptacles. Approved Feb. 1, 1912.

WAHLE, PHILLIPS CO., 549-551 West 52nd St., New York City. Straight electric, combination and portable fixtures. Approved Feb. 1, 1912.

Flexible Cord, Pendant.

AMERICAN STEEL & WIRE CO., Worcester, Mass. Marking: Soft woolen thread on rubber surface lengthwise of wire under braid. Approved Feb. 3, 1912.

GOODYEAR RUBBER INSULATING CO., 105 East 131st St., New York City. Marking: One red and two green threads cabled with copper strands. Approved Feb. 3, 1912.

MOORE, ALFRED F., 200 N. Third St., Phila. Pa. Marking: Red, white and blue cotton thread cabled with copper strands. Approved Feb. 6, 1912.

NATIONAL INDIA RUBBER CO., Bristol, R. I. Marking: Two blue cotton threads cabled with copper strands. Approved Feb. 3, 1912.

SIMPLEX ELECTRICAL CO., 110 State St., Boston, Mass. Marking: One red thread parallel with conductor between rubber insulation and braid. Approved Feb. 2, 1912.

Flexible Cord, Portable.

AMERICAN STEEL & WIRE CO., Worcester, Mass. Marking: Soft woolen thread on rubber surface lengthwise and under braid. Approved Feb. 3, 1912.

GOODYEAR RUBBER INSULATING CO., 105 East 131st St., New York City. Marking: One red and two green threads cabled with copper strands. Approved Feb. 3, 1912.

MOORE, ALFRED F., 200 North 3rd St., Phila., Pa. Marking: Red, white and blue cotton thread cabled with copper strands. Approved Feb. 6, 1912.

NATIONAL INDIA RUBBER CO., Bristol, R. I. Marking: Two blue threads cabled with copper strands. Approved Feb. 3, 1912.

OKONITE COMPANY, 253 Broadway, New York City. Cord for electric heaters. Double conductor composed of stranded tinned wires with cotton wind, rubber insulation and an asbestos braid assembled as a twin pair and covered by a single protecting braid over both strands. Marking: Ridge on rubber insulation. Approved Feb. 22, 1912.

Fuses, Cartridge Enclosed.

SIMPLEX ELECTRICAL CO., 100 State St., Boston, Mass. Marking: Red cotton thread upon smooth rubber surface lengthwise of wire and under braid. Approved Feb. 3, 1912.

BRINER ELECTRIC CO., 811-13 N. Second St., St. Louis, Mo. "St. Louis" enclosed cartridge fuses, 250 volts. Approved Feb. 7, 1912.

Fuses, Plug.

CONNECTICUT ELECTRIC MFG. CO., Bantam, Conn. Edison plug fuses, 0-30 A, 125 A. Approved Feb. 17, 1912.

UNION ELECTRIC CO., Trenton, N. J. "Union" Edison plug fuse, 3 to 30 A., 125 v. Approved Feb. 17, 1912.

Receptacles, For Attachment Plugs.

LOVELL & CO., F. H., Arlington, N. J. "Double Eagle" flush Edison screw receptacle marked, "D. E.," 660 w., 250 v. Approved Feb. 22, 1912.

METROPOLITAN ELECTRIC MFG. CO., East Ave. and 14th St., Long Island City, New York. Detachable body, flush receptacle, 10 A, 250 v. Approved Jan. 30, 1912.

Receptacles, Standard.

PASS AND SEYMOUR, INC., Salvay, N. Y. "P. & S." brass shell, key, 250 w., 250 v.; keyless, 660 w., 250 v. "P. and S." porcelain shell, key, 250 w., 250 v.; keyless, 660 w., 250 v. Approved Feb. 5, 6 and 14, 1912.

TRUMBULL ELECTRIC MFG. CO., Plainville, Conn. "Circle T" 660 w., 250 v. cleat, conduit and molding type. Approved Feb. 1, 1912.

Rosettes, Fuseless.

BRYANT ELECTRIC CO., Bridgeport, Conn. "New Wrinkle" rosettes with pull socket mechanism, 3 A, 125 v., 1 A, 250 v. concealed and cleat types. Approved Feb. 12, 1912.

HEINEMANN COMPANY, INC., GEO., 500 W. Girard Ave., Phila., Pa. 3 A, 250 v., cleat and molding types. Approved Feb. 22, 1912.

Sign Machines.

BETTS & BETTS, 302-306 West 53rd St., New York City. "New York Flashers." Type G and 4G, 0-30 A, 110 v.; type L. V., 66 A per switch, 10 volts A. C. Approved Feb. 22, 1912.

ECLIPSE ELECTRICAL MFG. CO., 416-418 Milwaukee ave., Chicago, Ill. "Eclipse Motorless Flasher." An oil-immersed switch with automatic solenoid control. Approved Feb. 1, 1912.

Switches, Combination Cut-out.

METROPOLITAN ENGINEERING CO., 1250 Atlantic Ave., Brooklyn, N. Y. Combination sealable service switches and cutouts, 250 volts, 0-30, 31-60 and 61-100 amperes, two fuses, solid neutral connection. These devices are not suitable for use in connection with secondaries not properly grounded. Approved Feb. 15, 1912.

Transformers.

HALLBERG, J. H., 36 East 23rd St., New York City. "Hallberg's Economizer" 110 or 220 v., 60 or 133 cycles. Transformers for moving picture lamps. Several primary leads are provided to care for the range of voltage of each normal rating. Approved Jan. 29, 1912.

VIKING ELECTRIC CO., 150-152 Chambers St., New York City. Bell ringing transformers or for signal work. Type A, 6 v. to 100-125 v.; type B, 6, 12 and 18 v to 100-125 v. Approved Feb. 1, 1912.

VICTOR ELECTRIC CO., Jackson Blvd. and Robey St., Chicago, Ill. Bell ringing transformers. Approved Feb. 12, 1912.

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A Code of Professional Conduct.

The American Institute of Electrical Engineers has adopted a code setting forth the principles that are to represent the standing of the body in matters relating to the professional conduct of electrical engineers. We present elsewhere in this issue the code as adopted, and beg the consideration of the honorable body in view of principle No. 19, if an expression of opinion is offered herewith. That the able members of the committee, giving birth to the code, recognized its need is fully confirmed by the character of the various sections. Why they hesitate to make it a part of the foundation for future growth and expansion of the Institute is not understandable, scarcely thinkable. Every engineer who is in active service knows that the condition under which engineering work is done today will not be influenced by gentlemen agreements or Sunday school resolutions. Laws without enforcement spells chaos and has been proven the rule whenever human nature has been involved. To preserve the engineering profession and keep in it those who value integrity and a high sense of honor above a contract, we must have some means of eliminating the unscrupulous engineer. That the Institute is in a position to work toward this end, no one can question. Its membership can be made such that a "black-ball" will mean sure professional death. Shall it therefore be a harbor for the "engineering quack" and a mask under which he can stab his fellow engineer? Does it appeal to good sense that a simple code of conduct, passed by the Institute and laid on the shelf simply as a crystalized expression of the existing sentiment of that body, will affect the conscience of that engineer who is in his everyday work taking from the profession that respect for truth, and engineering honesty, that is its very life?

We submit it to the honorable members of the committee submitting the code, if it is professional to pass up the code simply as an expression, allowing the Institute to continue its growth with practically no definite way of compelling respect for what now has become definite established principles of conduct. We fail to understand the logic on which the committee bases the following statement in its transmittal of the code to the directors of the Institute:

> "The Committee recognizes that the Institute's first code could not be rigid, but that as the standardization rules have developed through successive years under the guidance of a proper standing committee, in the same way the code of principles of professional conduct may be expected to develop. It would be impracticable to submit the code to the whole membership for the same reason that it has been found impracticable to submit the standardization rules to the same vote. If submitted to the vote of the membership, the frequent changes necessary for growth would be very seriously hampered."

Had the formulators of the Constitution of these United States worked upon this basis, it is safe to guess that we would not at the present time be enjoying the freest life of

the present divisions of the human race, nor our government be the model for the older nations of the continents. It has been found much easier to amend the too rigid and destructive of our rules of conduct, but a much more difficult thing to give them added jurisdiction.

Not everyone interprets rules of conduct alike, all such rules are broken and to continually break them without penalty is to forget and bury them. The conditions today have made principles of professional conduct in electrical engineering necessary. We now have the principles, the end is enforcement. It is our firm belief that now is the time to mend, and that if this chance to right matters is passed up, the whole work will die a premature death. Practice makes perfect; let's have a little practice.

Relation of Executive Ability to Specialized Knowledge.

In the concluding section of Harrington Emerson's presentation of the Principles of Efficiency, appearing in the Engineering Magazine, he makes the following statement which provides much food for thought: "The philosophy of efficiency is to be used to build roads along which any organization can travel with least friction and the greatest advantage, and the more ramified and involved the business the more is the philosophy needed." How many concerns and individuals are endeavoring to use this doctrine in just this way, but in their methods are, figuratively speaking, overloading their generators through a low power factor? What is needed to supplement their entire endeavor is one or more synchronous condensers apparently fanning the air at tremendous speed, yet from the standpoint of the man at the switchboard, increasing his station capacity and that of the entire equipment many fold. In line with this thought, we quote herewith from Mr. Glenn C. Webster, manager of one of the largest engineering and research organizations in this country.

The one great source of inefficiency in present day business administration is the lack of ability or desire on the part of executives to turn over to their subordinates work which the latter are perfectly capable of doing and in many cases are better able to perform than the executives themselves. No man has ever had a monopoly of brains. The fact that continual advancement is being made in all arts and sciences is in itself conclusive proof that the rising generation will be able to accomplish at least as much as men of today. Many of our executives, however, do not seem to realize this fact, but rather are laboring under the delusion that they alone are capable of performing the various physical and mental duties of their organization.

It has well been said that organization is the science of human nature. The real significance of this truth will be more generally understood ten years from now than it is at present. When the time comes that executives pride themselves more upon the men they develop than they do upon their own ability to perform their numerous duties, organization will come into its true meaning. No man today has enough money to carry on the vast business enterprises of the country, so that to the extent that one is able to obtain the money of others and handle it successfully, just to that extent is he a successful financier. The same principle applies when it comes to obtaining the enthusiastic, intelligent man-hours of others, which are of more importance than financial capital itself. Money without the assistance of brains cannot form an alliance between brains and capital, which is absolutely necessary in modern business. On the other hand, brains of the right kind can readily enlist enough capital to carry out any feasible project. Many of our captains of industry have found out, often to their sorrow, that if they had more brain power themselves or had availed themselves of the brains in their organization, less capital—yes, much less capital—would have been needed. It is perfectly logical, therefore, that as much time and thought should be spent in developing the brains and ability of men as is spent in obtaining and watching the capital of the business.

Most business organizations have a supply of quick assets to carry them over any sudden financial crisis that may arise, but how many concerns have a reserve stock of quick assets of brain and ability so that in case of emergency it is on call at any moment, day or night? Naturally, the question arises as to how executives are to maintain a loyal reserve supply of this mental and physical energy, should they already possess it? The only way to obtain a stock of brains and ability is to make and accumulate them, and the only way to develop, accumulate and hold loyal, quick ability assets is for the executive to turn over, as much as possible, of his work to others, spending more time with his men and less time in his private office shut off from the world. Not until executives realize this and assume as their most important duties the cultivation of their men and the developing of them to do things that must or should be done, will the efficiency of organizations be at its maximum.

The Small Motor's Useful Life.

Few people today, other than those directly connected with the design or manufacture of electric motors, appreciate the small motor evolution of the past few years. The small motor is not considered up to standard now by either the dealer or the consumer unless it will operate with little or no attention, perhaps not even regular lubrication, for at least one year. This has undoubtedly grown out of the fact that plenty of small motors are now in service that have never been carefully examined, yet have to their credit more than one year of satisfactory use. Certainly when a comparison of the useful life of the average fan or small motor is made with that claimed for some of the highest grades of electrical devices on the market, a most valuable compliment is paid to present day mechanical and electrical design and the high state of manufacturing methods of the small motor manufacturer.

Dealers and motor users who have the impression that small motors and fan motors are not always as satisfactory as they might be should take a few minutes to think over the conditions of average operation. It is said that the electric meter, of the commutator type, with the best of jewel bearings should be examined after every million revolutions, and those of the induction type inspected after not to exceed every three million revolutions. Suppose it were necessary to have the bearings of a fan motor examined and tested after one million to three million revolutions. This would mean expert attention no less than twice a week during the fan motor season. A majority of all the small motors in service would then require intelligent attention at least once a week and this fact alone would kill the fan and small motor business.

VIEWS OF UP AND DOWN STREAM SIDES OF DAM AND STATION.

The Barnett Shoals Development of the Athens Railway and Electric Company, Athens, Ga.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY C. D. FLANIGEN, VICE-PRESIDENT AND CHIEF ENGINEER.

DURING the early part of the year 1910, construction work was started on a hydro-electric development at Barnett Shoals, eleven miles below Athens, Ga., on the Oconee River. This plant was completed in March, 1911, and now forms a part of the hydro-electric system of the Athens Railway & Electric Company. The site of this development is just beyond the limits of Clarke county, about four miles below the junction of the Oconee and Middle Oconee Rivers, and at a point where the river is confined between precipitous banks of granite, providing a head of over 50 feet.

At the present time the Athens Railway & Electric Co. has three hydro-electric plants in operation on the Oconee River, one at Mitchell's Bridge, another at Tallahassee Shoals, and the one under discussion at Barnett Shoals. These three plants represent a total capacity of 5,200 K.W., which with the company's steam turbine auxiliary station of 1,500 K. W. at Athens, gives a total capacity of the system of 6,700 K. W. As already stated, the newest development is that located at Barnett Shoals and known as the James White power plant, or in the terms of the lease plant No. 4, being built by the James White Power Company, a construction organization which was not incorporated. The completed station with transmission line was leased to the railway company for a period of 99 years.

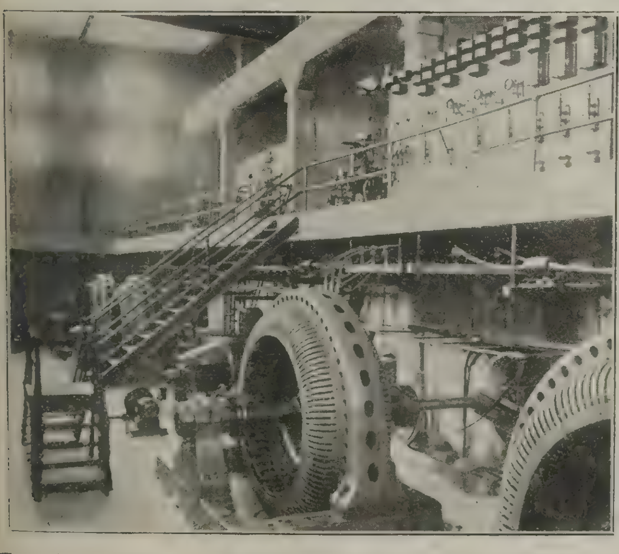


FIG. 1. INSIDE OF STATION SHOWING ARRANGEMENT OF MAIN UNITS.

The development and its promotion have as many unique features as any other hydro-electric project in Georgia or the South. It is unique first from the fact that the entire property is owned by an individual, Captain James White, of Athens, and was developed by him without bonds or other incumbrances. It is unique in that all the machinery for the plant, head gates, water wheels, governors, generators, switchboards, transformers, and lightning arresters was furnished by one manufacturer on a single contract. It is further unique, at least in the South, in the design of the dam, which is of the reinforced concrete type and in the construction of the power house, which is concrete throughout and forms a section of the dam. The penstocks, enclosed on two sides by the buttresses, form the up-river wall of the power house and the draft tubes being cast between and connecting the buttresses which form the foundation walls of the building.

The entire structure from one abutment landing to the other is reared upon solid rock. From the initial investigation, the site of the development was apparently most ideal, in that the bed of the river seemed to be hard granite and the abrupt banks promised an easy anchorage for the shore ends. Not all of these ideals, however, were realized, for the south section of the river for about 175 feet proved to be of such a faulty nature, below the superposed rock, as to require considerable blasting and the removal of rock and gravel to obtain the solid foundation required.

THE DESIGN OF DAM.

The design of the dam is similar to that of the old wooden dam, so universally used in small power develop-

ments, constructed of bents tied to a mud still, with the inclined face covered with a wooden floor. The exception is that reinforced concrete is substituted for the wood, the intimate joining of the concrete to the rocky foundation proving as effective a bar to an undermining tendency of the water under pressure as the sheet piling on the up-river side of the old time mud sill, which received the most careful

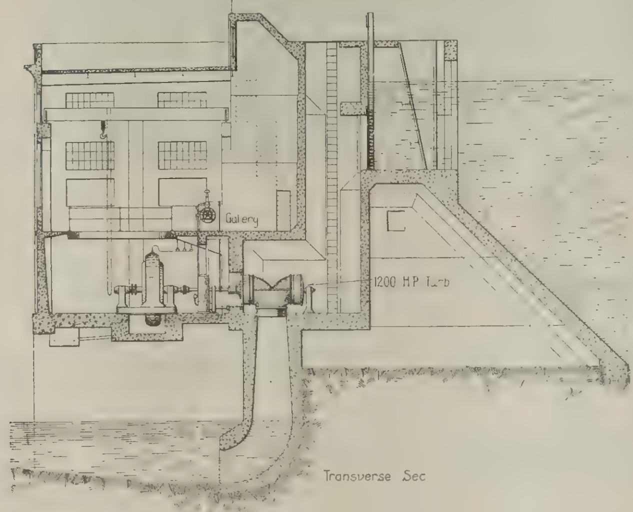


FIG. 2. SECTION OF STATION THROUGH GENERATOR UNIT.

attention from the successful timber dam builder. The foundation for the buttresses and for the up-river cut-off were carefully prepared, all loose, weathered or rotten rocks being removed and the sectional forms for the buttresses placed in position so as to bring the tops to a uniform level, the space below the sectional form and between it and the rock being enclosed with made up forms. The up-river slope of the buttress, flared to form a hunch, makes a bed for the deck slab, that will allow for its expansion and contraction with changes in temperature. The buttresses were carried up in sections ten feet high, the joints between the old concrete and new being carefully picked and thoroughly cleaned.

The decks were cast after the buttress forms for that particular rise had been removed, the batch being poured from the next level. In this way each buttress was the counterpart of the preceding one, the work progressing in regular steps. Three types of buttresses make up the span from contour to contour. Those forming the abutments are four in number on the south side and seven on the north side, the latter occupying the space between the power house and the bluff. Two other types are those forming the spill-

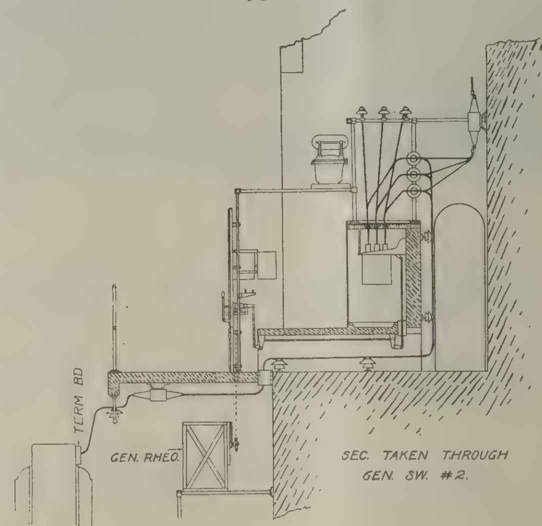


FIG. 4. ARRANGEMENT OF SWITCHING APPARATUS.

way section and the power house section. From the power house through the spillway section to the south bank of the river a passage way through the buttresses serves the double purpose of a walk-way across the river and a means through the openings of supplying air behind the mass of falling water, breaking the insidious vacuum that is a menace to the stability of river structures.

The datum adopted by the engineers in the original surveys was the normal elevation of the water at the head of the shoals above which the water was raised four feet. The crest of the dam was at elevation 104 and the bed of the river averaging 60 feet, making the height 44 feet, with ten feet added on the abutments to care for any possible flood water. The tail race, about 800 feet long and 70 feet wide, was blasted out to elevation 50. The elevation of the tail

FIG. 3. INSIDE OF STATION SHOWING SWITCHBOARD GALLERY.

water with all the wheels operating was calculated to be 53.5, giving a fall of 50.5 feet under normal conditions. In the power house, which is 102 feet long, the elevations are, floor of pit 70, center of wheels 73.5, main floor 82, crane girder 98, and roof 105.6 to 106.2. The elevation of the water at the foot of the shoal is 47, giving a fine run off. The penstocks and draft tubes are of concrete, the former being of the open type, 15 feet, six inches by eight feet, with double gates, 7 by 9 feet each, guarding the entrance to the penstocks for the four generator units and a single gate 5 feet by 8 feet, 3 inches for the water driven exciter unit. The buttresses from the power house to the south side of the river are on 18 feet centers, and those in the power house and north abutment are 17 feet, the up river slope of the former being 7:6 while the latter are somewhat steeper at a slope of 1:1. A clear idea of the general construction can be obtained from the illustrations. The total length of the south abutment is 70, of the spillway 522 feet, of the power house including bay between it and the spillway 119 feet, and the north abutment 120 feet.

An interesting feature of the work was the final closure. The abutments for the closure, four in number, were carried up perpendicular from the cut off and a slab cast at elevation of 71.5 feet spanning these enclosing walls. Rebates were left in the up-stream face for the stop gates which were framed of heavy pine timbers securely bolted and ironed. When the time for the final closure arrived, a section of the crest having been left open, the beds for the three deck slabs were carefully prepared and the seats of the gates cleared of all rock and other obstruction by divers. The gates in the meantime had been hung to a hoisting engine and when everything was ready were dropped one at a time to their beds and the river began to build up. From the inside, the gates were thoroughly braced and active work begun in casting the three permanent closure decks, weep pipes being left to prevent any building up of pressure on the green concrete. The batch from the mixer was handled through the open crest. In twenty-eight hours after the dropping of gates water was trickling over the crest and four hours later had reached its normal depth at that stage of the river, of five inches. After the decks had been cast behind the wooden gates, the crest was poured and the work was complete.

STATION EQUIPMENT.

The equipment of the station consists of four pairs of 30-inch Allis-Chalmers water wheels set in open concrete penstocks and direct connected to four 700 K.V.A., 12,000 volt, 3-phase generators of 360 r.p.m., with one 20-inch wheel operating at 450 r.p.m., direct connected to a D.C. 125 volt exciter of 100 K.W. capacity. These generators are set on a floor elevation of 70 feet, their centers being 20 feet above tail water. Solid concrete pressure walls protect them from any known high water records. On the

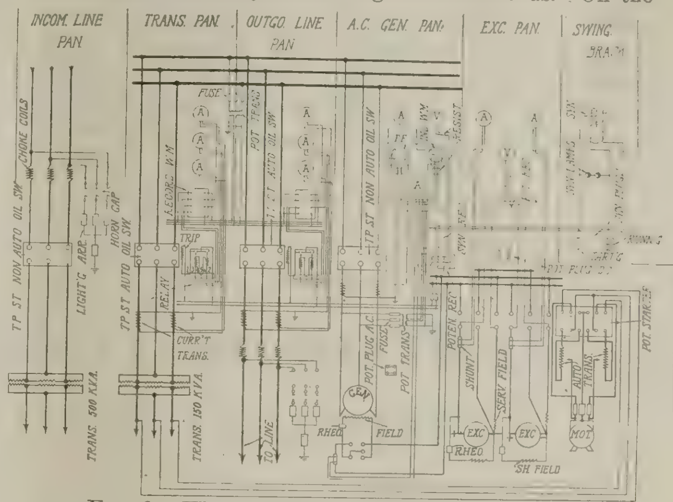


Fig. 6. Wiring Diagram for Switchboard.

main floor, which forms a gallery around the generator pit, are installed eight marble switchboard panels with remote control oil switches in brick cells, one motor generator set of 100 K.W. capacity, arranger to work in parallel with the water driven exciter or independent of it, either being capable of supplying all the excitation needed for the four generators, two banks of electrolytic lightning arresters and three 150 K.V.A. 12,000 to 23,000 volt transformers furnishing current for the motor generator and for the Star Thread Cotton Mill located about 1,200 feet up the river.

On this floor also are four Allis-Chalmers open tank governors with their several oil pumps and tanks on the lower floor, and one small self-contained governor of the same make but of different type, connected to the 20-inch

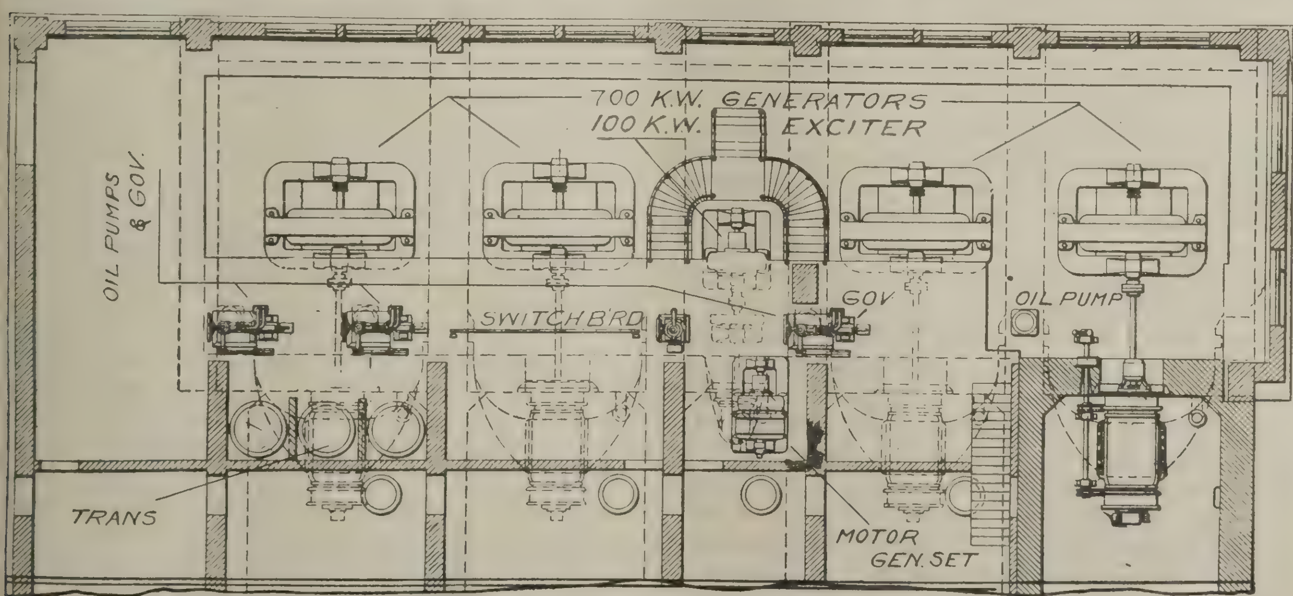


Fig. 5. Plan of Power Station.

wheel driving the exciter. The governors, which are exceedingly rugged in design throughout are placed on the upper floor for the convenience of the operators, and are connected to the gate shafts by latticed connecting rods, that eliminate lost motion, and make the action of the governors prompt and positive.

In the last bay of the power house is constructed a three flight steel stairway leading to the roof with an additional flight outside leading to an elevation of 114 feet, the level of the abutments and the highest elevation excepting that of the tower through which the three sets of transmission wires leave the building. These stairways permit the attendants to reach the operating mechanism of the head gates, when it is necessary to inspect or operate them, and give access to the steel ladders leading to the wheel compartments in the penstocks.

The power house is equipped with a Pawling & Harnishfeger 10-ton crane, and is lighted with tungsten lamps. The window openings are fitted with Fenestra sash glazed with ribbed glass, excepting the lower four rows, which are plain glass. A Kinnear steel door covers the large entrance with a 5 by 8-foot door for ordinary service. Entrance to the power house from the road on the 114 elevation for pedestrians, is down a flight of concrete steps, or for vehicles by a driveway of reasonably easy grade, extending below the site of the station curving and returning along the edge of the tail race.

The erection of the plant was under the supervision of W. T. Bryan, President of the Athens Railway & Electric Company, with C. D. Flanigen, Second Vice-President of the same company as chief engineer. The concrete work on the dam and power house was done by the Ambursen Hydraulic Construction Company, with W. E. Maxson as superintendent. The Allis-Chalmers Company, of Milwaukee, furnished the entire equipment of the station, excepting the crane which, as stated, came from the shops of the Pawling & Harnishfeger Co., also of Milwaukee.

Instrument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY E. P. PECK, ASSISTANT ELECTRICAL ENGINEER, GEORGIA RAILWAY AND POWER COMPANY.

Checking Watthour Meters and Testing Polyphase Watthour Meters.

POWER in a three phase circuit may be measured with two single phase meters, using the algebraic sum of the readings as the total power, but it is advisable to use one polyphase watthour meter as one of the single phase meters will run backwards if the power factor of the circuit is below 50 percent. The algebraic sum of the readings will be the true watts in any case, but it is often confusing to have one meter record forward part of the time and backward part of the time.

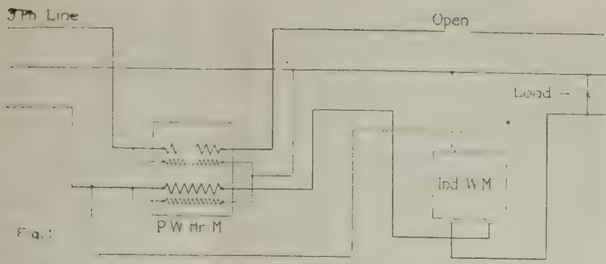
The polyphase meter is essentially two single phase meters with the discs on one shaft and the total power is recorded on one dial. The two elements are so arranged that the interference from stray fields of each on the other is a minimum. When testing a polyphase watthour meter both potential coils should be connected to the line. If the test is to be made on a three phase line the potential coils should be left on their regular connections and if tested on a single phase circuit the two potential coils should be connected in parallel. The diagram of connections for each method of testing is shown in Figs. 1 and 2.

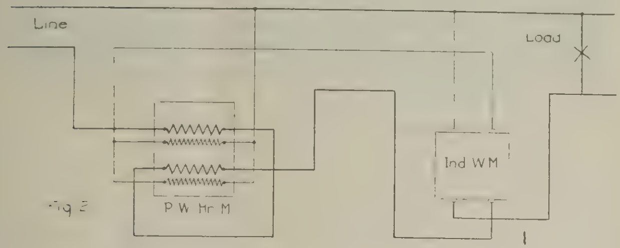
The reason why it is necessary to connect both potential coils, regardless of whether one or both elements are to be tested, is that when the meter is in operation on a three phase line, both potential coils are excited regardless of the amount of load or balance of load on the line. Each potential coil sends a magnetic flux through the disc, which in a measure acts as a drag magnet. If one coil is disconnected, the flux from that coil is removed and the retarding force on the disc is changed from the condition of normal operation. Each potential coil also furnishes a portion of the starting torque for the light load adjustment, so removing either coil would change the test results regardless of the change in retarding force.

Tests have been made which show that large errors are made when a polyphase meter is tested as two single phase meters—that is, with one potential and one current coil connected. It is essential that the potential coils of the standard meter and the tested meter be connected so that the power used by them is not measured by any of the meters and so that all potential coils receive the same voltage. Proper connections are shown in all of the diagrams given.

With the two potential coils connected, the meter is generally calibrated one element at a time, the current coil of the other element being disconnected. It is evident that both elements cannot be separately adjusted by moving the magnets and light load adjustments. That is, if one element is properly adjusted by this means, the magnets should not be changed to bring the other element correct, as it would change the calibration of the first. The meters are adjusted at the factory so that both elements record the same, but the adjustment is not absolutely permanent in all cases, and some meters are so made that one driving element may be adjusted by shifting its position or by some other means.

The meter may also be checked with the potential coils in parallel and the current coils in series, if the elements are known to be adjusted the same. With this connection, the meter will run at double speed and one half of the calibrating constant must be used for calculating the watts measured. The cause for this is that the current passing through the standard meter traverses two current coils in the tested meter and as each of the elements measures the wattage passing through it, the same power is measured twice and the meter runs at double speed. The three wire single phase meter also runs at double speed when the cur-





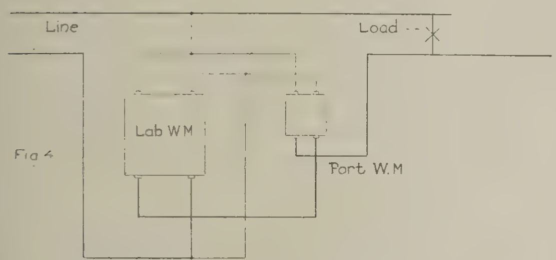


FIG. 1. CONNECTIONS FOR CHECKING POLYPHASE WATT-HOUR METERS. POTENTIAL COILS CONNECTED TO 3-PHASE LINE. FIG. 2. SAME AS FIG. 1, WITH POTENTIAL COILS IN PARALLEL AND CURRENT COILS IN SERIES. FIG. 4. CONNECTIONS FOR DIRECT COMPARISON.

rent coils are connected in series for test, for the same reason.

TESTING METERS WITH CURRENT AND POTENTIAL TRANSFORMERS.

Alternating current meters for large power or for voltages over 600 are supplied through instrument transformers. These transformers may be the source of large errors if not properly connected or if too many instruments are connected to them. Care should be taken that the load on all instrument transformers does not exceed the rating in watts marked on the transformer name plate. The load referred to here is not the load on the primary line, but is the number of volt-amperes the transformer must furnish

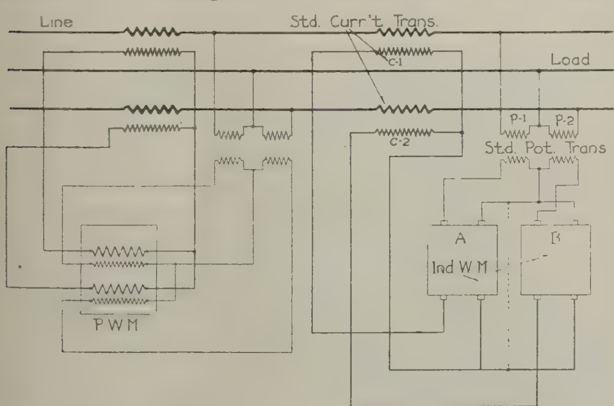


FIG. 3. CONNECTIONS FOR CHECKING POLYPHASE WATT-HOUR METER WITH ITS TRANSFORMERS CONNECTED.

Referring to Fig. 3, the following relations exist:

Primary watts $= A \times RP_1 \times RC_1 + B \times RC_2 \times RP_2$

where A = Reading of one indicating wattmeter.

B = Readings of other indicating wattmeters.

RC_1 = Corrected ratio of current transformers on wattmeter A.

RP_1 = Corrected ratio of potential transformers on wattmeter A.

RC_2 = Corrected ratio of current transformers on wattmeter B.

RP_2 = Corrected ratio of potential transformers on wattmeter B.

through its secondary windings to the instruments, when the primary line is carrying full load.

On account of the transformer errors, the meter should be tested with its current and voltage transformers connected, and should be adjusted to record the watts in the primary circuit. The meter should then be disconnected

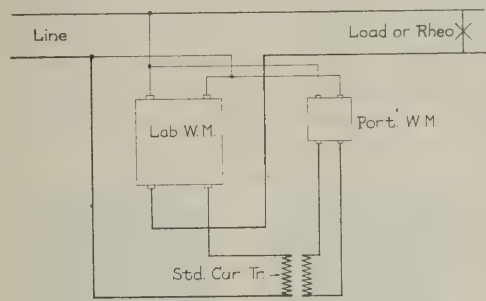


FIG. 5. CHECK OF METERS WITH STANDARD CURRENT TRANSFORMER.

from its transformers and tested on the same loads as a secondary meter, using connections as shown in Fig. 6. The difference in the primary and secondary checks is the error caused by the transformers. After having once determined the transformer error, the meter may be checked as a secondary meter on all regular tests, the readings being corrected for the transformer error. The connections for the primary check are shown in Fig. 3.

The standard meter used for the checks on the primary lines should be connected to its own current and voltage transformers, and the error of the standard transformers should be known and the corrections applied accordingly. The standard voltage transformer error is usually negligible, but the current transformer error should be measured unless curves of the error are supplied by the manufacturers. Precision checks on current transformers are very difficult to make and require such a large amount of apparatus that the central station laboratory would not be justified in attempting to make them.

A very satisfactory check may be made, however, by the following method, using only the apparatus and instruments given in the layout of the laboratory in a previous section of this series. The current transformer to be tested will be assumed to have a rating of 1000 amps. primary and 5 amps. secondary, ratio 200:1, and is of the "doughnut" or through type, as shown in Fig. 2, page 102, of the March number. As the ratio is 200:1, 200 turns of No. 14 wire may be threaded through the hole in the transformer—counting the wires that pass through the hole, and not those on the outside—and with a current of 5 amperes through the wire, the primary ampere turns will be $200 \times 5 = 1000$, which gives the same flux in the iron as one turn with 1000

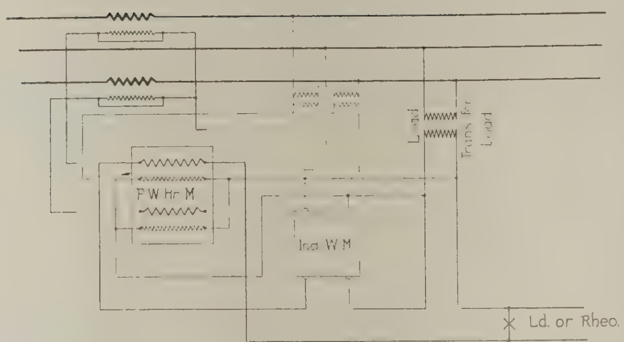


FIG. 6. CONNECTIONS FOR CHECKING POLYPHASE WATT-HOUR METER AS A SECONDARY METER ON SINGLE PHASE, TESTING EACH ELEMENT SEPARATELY.

amps. would give. The laboratory wattmeter and a portable wattmeter are checked together on each long division of the scale up to 500 watts, with 100 volts. The laboratory wattmeter is then connected to the 200 turn primary of the current transformer, and the portable wattmeter to the secondary. The ratio of the transformer has been made 1 to 1, and if there were no error in the transformer, the two wattmeters would read the same as on the direct check.

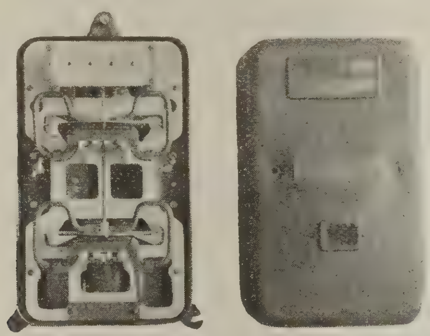
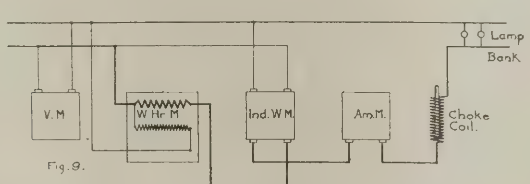


FIG. 8. A TYPE OF 3-PHASE INDUCTION WATT HOUR METER.

With the meters connected to the transformer another check is run, holding the same values on the laboratory meter as formerly. The difference in the readings of the secondary wattmeter, on the direct check and the transformer check, gives the error of the transformer. This error is reduced to percent error for each point and is used as a correction to apply to the meter reading each time it is used with the transformer.



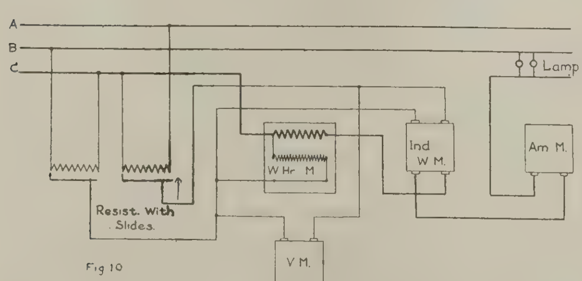
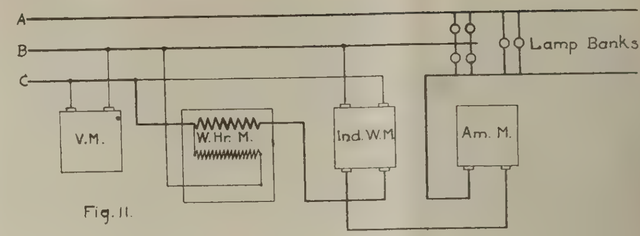


FIG. 9. CONNECTIONS FOR LOW POWER FACTOR CHECKS FROM SINGLE PHASE CIRCUIT. FIG. 10. SAME CHECKS FROM THREE PHASE LINES.



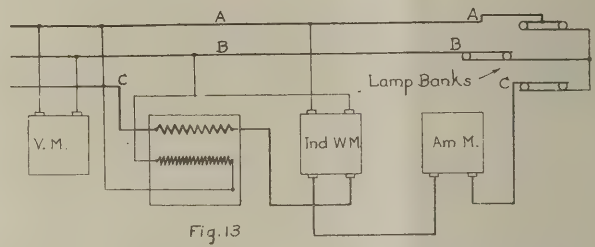


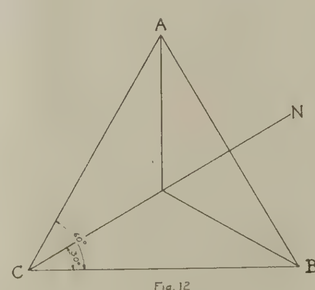
FIG. 11. OTHER CONNECTION FOR SAME TEST AS FIG. 10.
FIG. 13. CONNECTIONS FOR POWER FACTORS BELOW 50 PER CENT., LAMP BANK CONNECTED IN STAR.

If other meters requiring a secondary output from the current transformer are used, it will be necessary to make a check of the transformer with them connected, as the error is different for different secondary loads and for different frequencies. Connections are shown for these checks in Figs. 4 and 5.

When the watthour meter is to be tested separate from its transformers, particular care should be taken to short circuit the secondary terminals of the series transformer. If a load is put on a current transformer with its secondaries open a very high voltage is produced which may damage the transformer or severely shock the tester, and in addition the transformer will heat excessively. The short should not be removed until the meter is reconnected for service.

TEST ON LOW POWER FACTORS.

If watthour meters are connected to circuits supplying induction motors or other apparatus giving a low power factor, checks made on the meter at 100 per cent power factor are not sufficient proof of its accuracy under service conditions. A meter may be correct at 100 per cent power factor and greatly in error at 50 per cent power factor. If a single phase supply is all that is available, a low power factor may be obtained by connecting a choke coil in series with a lamp bank for load as shown in Fig. 9. A coil with a movable plunger is preferable. By changing the position of the plunger and the number of lamps connected in the lamp bank, different loads and different power factors may be obtained.



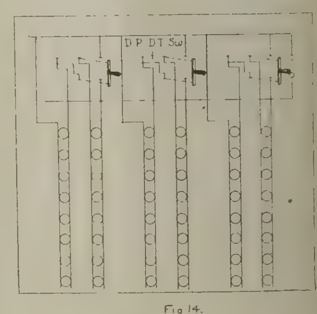


FIG. 12. SHOWING RELATIONS OF CURRENT AND VOLTAGE FROM FIG. 13. FIG. 14. WIRING DIAGRAM FOR 48 LAMP BOARD.

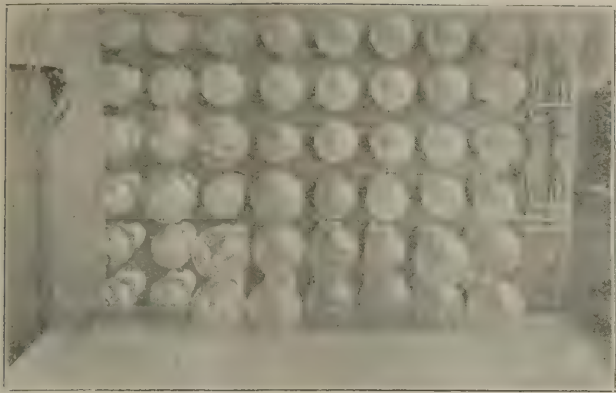


Fig. 15. A Convenient Lamp Bank Arrangement.

The power factor equals the watts divided by the product of the volts and amperes, hence a voltmeter and ammeter are necessary in these checks for obtaining the volt-amperes. If a three phase line is available, the low power factor may be obtained by taking the current from one line and the voltage from slide resistances connected to the three lines, or by taking voltage from two of the lines and current from three lamp banks connected to the three lines. Connections are shown for these two methods in Figs. 10 and 11 respectively.

Referring to the vector diagram in Fig. 12, lines AB, BC, AC, represent the voltages, and their relative phase positions, between lines A and B, B and C, A and C, respectively. The meter current coils are in series with line C, and if both current and voltage are taken from lines B and C, with a non-inductive load, the power factor of the load will be 100 per cent. If the current is taken from line BC and the voltage from lines AB, as shown in Fig. 10, the current and voltage differ in phase position by 60 degrees and the power factor is 50 per cent. Any power factor from 50 to 100 per cent may be obtained by changing the position of the slides on the resistance coils. The current may be made to lead or lag, and as meters are usually used on lagging power factors, it is necessary to know which is being obtained. Connect a small choke coil in series with the current circuit. If the insertion of the coil reduces the power factor the slides are set for a lagging current. The same results are obtained by the connections as shown in Fig. 11, except that the phase position of the current, instead of the voltage, is shifted.

If power factors below 50 per cent are desired, the lamp banks are connected in star as shown in Fig. 13. With the same number of lamps connected in banks A, B and C, the

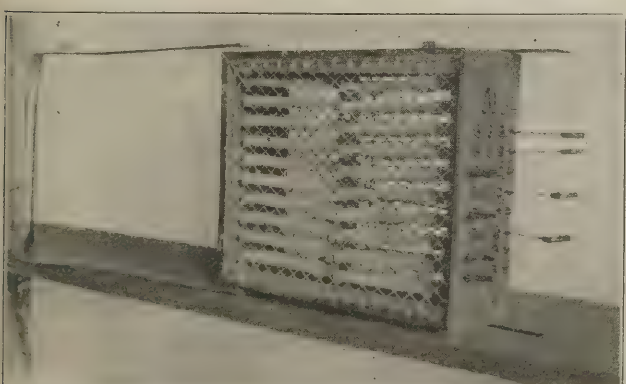


Fig. 16. A Convenient Portable Rheostat.

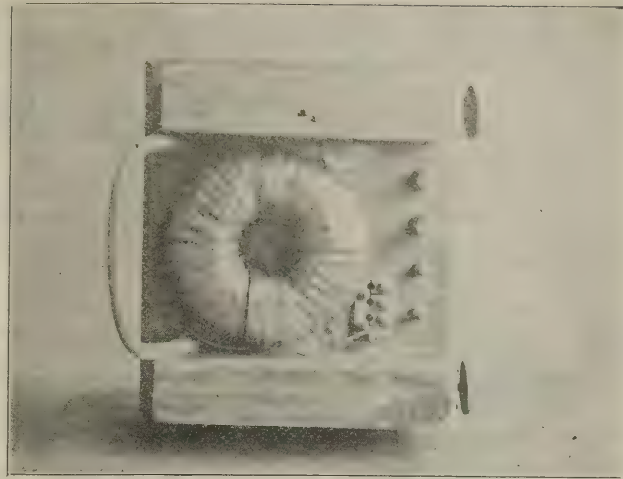


Fig. 17. A Load Transformer for 5 Amperes.

current is in the direction CN, Fig. 12, and voltage is in direction AB. The current and voltage are now at right angles to each other and the power factor is zero. This of course neglects the reactance of the coils of the meters and is not strictly true for the condition of balanced load from C to A and B. Any power factor from 0 to 50 per cent may be obtained by changing the number of lamps in banks.

The tests given above for leading and lagging power factors should be applied in this case also. By shifting the potential leads from line A to line C power factors from 50 to 100 per cent may be obtained with proper loads on each bank.

The standard meter used on low power factor checks should not be assumed to be correct on low power factors unless it has been proven to be so by some reliable authority properly equipped to make such checks.

PORTABLE RHEOSTATS AND LOAD DEVICES.

All tests on the line and some tests in the shop require some portable rheostat for adjusting the load. A lamp bank of from 10 to 50 lamps arranged so that the two rows of each pair may be thrown in series or parallel with each other is easily made and in common use. Such a lamp bank and its connections are shown in Figs. 14 and 15. There are a number of portable rheostats similar to that shown in Fig. 16, which are much smaller than a lamp bank of similar capacity, and are more durable. These rheostats are used when testing with full line voltage for the current supply. When large meters are to be tested a separate low voltage source of current is preferable. For direct current work, 1 to 3 cells of a storage battery of suitable capacity put in a carrying case, and a low voltage carbon rheostat make a very practical outfit. A small low voltage transformer with a rheostat is very convenient for alternating current meters of 25 amperes capacity and smaller. A load transformer for 5 ampere meters is shown in Fig. 17. On each side of the transformer are carbon rheostats which are used for load adjustments.

NOTE.—The writer failed to give the proper credit for the "Curve of Portable Reading Errors for Even Scale Meters" given on page 104 of the March issue. It was previously published in the Electric Journal, in an article by Mr. B. B. Bracket, in 1905. I remembered seeing, several years past, a curve similar to the one used, but my search did not locate it and for this reason credit was not given for its previous publication. Since the publication of the curve the original has been found as mentioned above, appearing in The Electric Journal. The other curves of instrument errors given in my article have never been published as far as I know.

E. P. PECK.

A Study of Polyphase Relations by Kirchoff's Laws.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY B. C. DENNISON, ASST. PROFESSOR ELECTRICAL ENGINEERING, CARNEGIE TECHNICAL SCHOOLS, PITTSBURGH, PA.

The Solution of Various Problems, Giving the Vector Relations for Each Case.

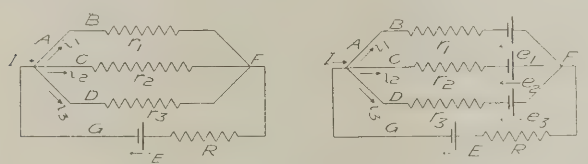
IT has been the experience of the author, both as student and teacher, that the relations of pressures and currents in polyphase circuits are often greatly confused by the student in his first study of the subject. This confusion is due in large measure, I believe to the failure to adopt a definite and unchanging system of vector representation, and to apply in a proper manner, the established laws of the electric circuit. Due to this lack, the student is frequently at a loss to know whether a certain pressure difference between two points is the sum or difference of the component pressures, and what relations exist between the currents in several branch circuits and the current in a common wire. It is in the hope of being of some assistance to those who experience these difficulties that the following article has been written.*

KIRCHOFF'S LAWS APPLIED TO DIRECT-CURRENT CIRCUITS.

The solution of direct-current problems, involving a network of conductors supplied with current from one or more sources of electromotive force, has been made a comparatively simple matter upon the establishment, by Kirchoff, of two laws bearing his name. These are as follows:

1. The algebraic sum of all the currents flowing all from or all toward any node of the network, is zero.

II. The algebraic sum of the electromotive forces taken completely around any circuit of the network, is zero. In law II it should be understood that the emfs produced by, rather than those consumed by resistances, are referred to.



FIGS. 1 AND 2. SIMPLE CASES OF DIVIDED CIRCUITS WITH AND WITHOUT COUNTER EMFS.

To illustrate the application of these laws to a simple direct-current circuit the network shown in Fig. 1 will be solved for the current I. In the figure the assumed directions of the several currents are shown by the arrows with the closed barbs; the directions assumed for the emfs are shown by arrows with the open barbs. Whereas the accuracy of the solution is not affected by whether the assumed directions agree with the actual direction of currents and emfs, it is absolutely necessary that the assumption be adhered to throughout the solution.

Applying Law I to the node at A, and noting that currents are measured all toward the node, it is found that,

$$I-i_1-i_2-i_3=0 \qquad (1)$$

For the loop ABFCA, Law II gives that

$$-i_1r_1+i_2r_2=0 \qquad (2)$$

The signs here correspond to the emfs produced rather than those consumed, as already stated.

For the loop ABFDA

$$-i_1r_1+i_3r_3=0 \qquad (3)$$

For the loop GABFG

$$E-i_1r_1-IR=0 \qquad (4)$$

From eq. (2), $i_2=i_1r_1/r_2$

From eq. (3), $i_3=i_1r_1/r_3$

So that (1) becomes

$$I=i_1+i_1r_1/r_2+i_1r_1/r_3 \qquad (5)$$

From eq. (4), $i_1=E-IR/r_1$

So that (5) becomes

$$I=(E-IR)/r_1+(r_1/r_2)\,(E-IR)/r_1+(r_1/r_3)\,(E-IR)/r_1$$

Collecting terms, we have,

$$IR(1/R+1/r_1+1/r_2+1/r\ )=E(1/r_1+1/r_2+1/r_3) \qquad (6)$$

Denoting the quantities within the parenthesis by (a) and (b) respectively

$$IR\,a = E\,b$$

or $$I=E\,(b/Ra) \qquad (7)$$

Assume the quantities involved to have the following numerical values:

$E=110$ volts, $r_1=4$, $r_2=3$; $r_3=5$ and $R=2$ ohms,

Then $a=1.28$ mho

$b=0.78$ mho

Therefore $I=110\ (0.78/1.28x2)=33.5$ amp. (ans.)

The above network might have been solved more easily by applying Ohm's Law and finding the equivalent resistance of the circuit. Thus,

$$Req.=R+(r_1+r_2+r_3)/(r_1r_2+r_2r_3+r_3r_1)=3.275 \text{ ohms}$$

And, $I=E/Req. = 110/3.275=33.5$ amp. (ans.)

This answer checks with that obtained above. In the above example Kirchoff's Laws were used, not because they gave the simplest solution, but in order to illustrate the application of these laws to a network which could be readily solved by another method and so the accuracy of the method be illustrated.

If a more complicated network be considered, such as that of Fig. 2, Kirchoff's Laws become almost indispensable to a solution. Solving as before:

Law I gives that, at A,

$$I-i_1-i_2-i_3=0 \qquad (8)$$

Law II applied for the loop ABFCA gives that

$$-i_1r_1-e_1+e_2+i_2r_2=0 \qquad (9)$$

For the loop ABFDA

$$-i_1r_1-e_1+e_3+i_3r_3=0 \qquad (10)$$

For the loop GABFG

$$E-i_1r_1-e_1-IR=0 \qquad (11)$$

From (9) $i_2=(i_1r_1+e_1-e_2)/r_2$

From (10) $i_3=(i_1r_1+e_1-e_3)/r_3$

Substituting these values in (8)

$$I-i_1-(i_1r_1+e_1-e_2)/r_2-(i_1r_1+e_1-e_3)/r_3=0 \qquad (12)$$

But, from eq .(11) $i_1=(E-IR-e_1)/r_1$

Substituting this value of i_1 in eq. (12)

$$I-(E-IR-e_1)/r_1-(E-IR-e_1)/(r_1/r_1r_2)-(e_1-e_2)/r_2-(E-IR-e_1)/(r_1/r_3r_1)-e_1-e_3)/r_3=0$$

or $$IR(1/R+1/r_1+1/r_2+1/r_3)=E(1/r_1+1/r_2+1/r_3)-(e_1/r_1+e_2/r_2+e_3/r_3) \qquad (13)$$

This may be written in the simplified form

$$IRa=Eb-c.$$

Equation (13) is seen to be like eq. (6) except for terms containing the added emfs of the branches.

*See also article in The General Electric Review for Oct., 1911; Vectors of Polyphase A. C. Circuits, by L. E. Blume.

Assuming the same values as before with the added values:

$e_1=20$, $e_2=25$, and $e_3=30$ volts,
then a = 1.28 mho, as before,
b = 0.78 mho, as before,
c = 19.33

Therefore, $I=(Eb-c)/Ra=(110\times0.78-19.33)/(2\times1.28)$
$= 25.9$ amperes. (ans.)

The circuit network of Fig. 2 corresponds to three sections of a storage battery placed in parallel for the purpose of charging on a source of low emf. In such a case the regulating resistance, R, should be variable.

These examples of the application of Kirchoff's laws are given for the purpose of recalling these laws to memory in order that their use in a. c. networks may be more readily appreciated.

KIRCHOFF'S LAWS APPLIED TO A. C. CIRCUITS.

In the solution of problems relating to alternating current circuits, whether single or multiphase, Kirchoff's Laws still apply, although in a somewhat modified form. These laws, as stated by Messrs. Bedell and Pierce (see "Direct and Alternating Current Testing") are as follows:

Law Ia. The Vector Addition of Currents. The vector sum of all the currents meeting at any node of the a. c. network is zero, when the currents are measured all toward or all away from the common point; the vectors form a closed polygon.

Law Ib. Vector Subtraction of Alternating Currents. At a point in an alternating-current systtem, where three currents come together, if one current is measured toward and one from the point, the third current is the vector difference of the other two. Thus in Fig. 3,

$I_3=I_2-I_1=I_2$ plus $(-I_1)$.

Law IIa. The Vector Addition of Alternating Electromotive forces. The vector sum of all the emfs, measured all in a clockwise, or all in a counter clockwise direction around the circuit, is zero, when taken completely around any circuit of a. c. network; the vectors form a closed polygon.

Law IIb. Vector Subtraction of Alternating E. M. Fs. In an a. c. system, if two emfs are separately measured away from a common point, as Eoa and Eob, in Fig. 4, the potential difference Eab between the outer points, as a and b, is the vector difference of the two emfs, Eoa and Eob., and, since Eab is the pressure from a to b it may be considered as Eao plus Eob which is Eob—Eoa.

APPLICATION OF KIRCHOFF'S LAWS TO POLYPHASE SYSTEMS.

The current and pressure relations in polyphase systems may be readily deduced from the laws stated above. The following symmetrical systems will be considered.

1. Quarter-phase, star-connected and mesh-connected systems.
2. Three-wire, quarter-phase system.
3. Three-phase, star and mesh connected systems.
4. Three-phase V-connected systtem.
5. Three-phase T-connected system.
6. Three-phase to two-phase transformation, by the Scott system.
7. Three-phase to two-phase transformation, by the three transformer (Taylor) method.

IA. RELATIONS IN QUARTER-PHASE STAR-CONNECTED SYSTEM. PRESSURE RELATIONS.

Referring to Fig. 5, the emfs Eoa, Eob, Eoc, and Eod, are, by the definition of the system, equal in magnitude and displaced in phase by 90 degrees. Note that they are measured all away from the common point, O. Their vectors are shown in Fig. 6. To find the emf Eab, Law II-b is applied, giving that Eab is the vector difference between Eob and Eoa, i. e. Eab = Eob plus (—Eoa). Thus, in Fig. 6 Eoa has been reversed in direction and added to Eob, giving Eab. It is evident from the figure that Eab leads Eob by 45 degrees and has the value $\sqrt{2}\times$ Eob. Thus in a symmetrical quarter-phase system, star-connected, the pressure between wires $=\sqrt{2}\times$ pressure per phase. By symmetry the remaining pressures, Ebc, Ecd, and Eda are as drawn in Fig. 6.

Note that these vectors, the pressures being measured all in, say, the counter clockwise direction, form a closed polygon.

CURRENT RELATIONS. In the star-connected quarter-phase system the phase currents and line currents are identical. If the loads be non-inductive, the currents Ia, Ib, etc., are in phase with the respective phase pressures, Eoa, etc., and lag 45° with respect to the line pressures, Eab, Ebc, etc., as shown in Fig. 6. If the phase current, as Ib lags $\Theta°$ with respect to the phase emf Eob, it lags $45°+\Theta°$ behind the line pressure Eab, as seen in Fig. 7.

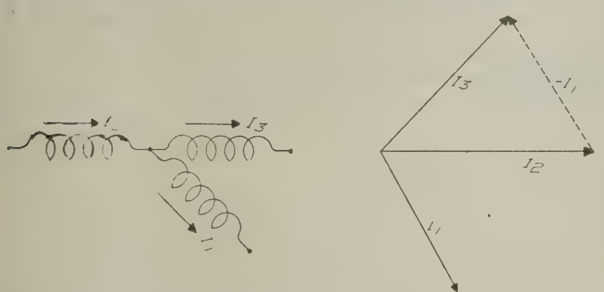


FIG.3.

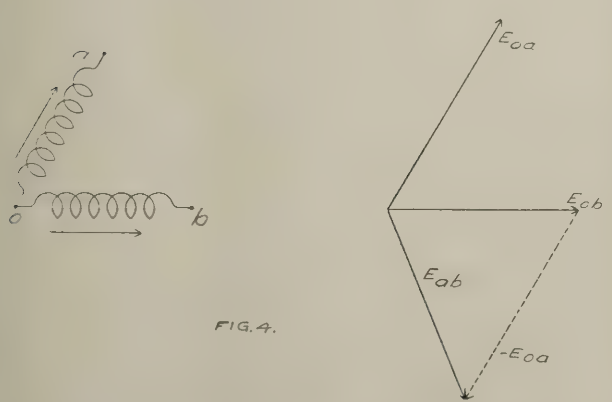


FIG. 3. DIVISION OF CURRENTS AT A COMMON POINT. FIG. 4. PRESSURES MEASURED AWAY FROM A COMMON POINT.

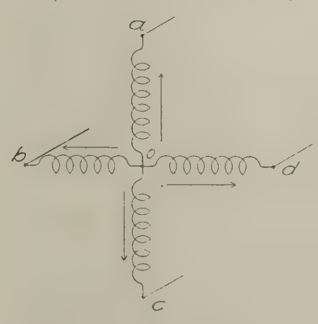


FIG.5.

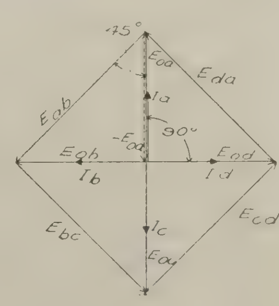


FIG 6

FIG. 5. QUARTER-PHASE WINDINGS, STAR CONNECTION. FIG. 6. VECTOR RELATIONS IN QUARTER-PHASE, STAR-CONNECTED SYSTEM.

IB. RELATIONS IN QUARTER-PHASE, MESH-CONNECTED SYSTEMS. PRESSURE RELATIONS.

The phase pressures are measured all in, say, the counter clockwise direction (see Fig. 8). Their sum is zero so that there is no tendency for local currents to flow within the mesh. Since the line wires are connected to the terminals of the phase windings the e. m f. between adjacent wires = the phase emf., in the mesh-connected quarter-phase system. The emf between opposite wires is the geometric sum of the emfs of adjacent phases, or, in Fig.

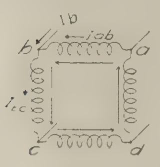


FIG. 8.

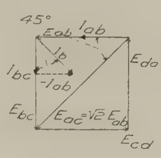


FIG. 9.

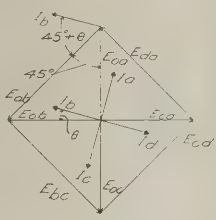


FIG. 7.

FIG. 7. RELATIONS WITH INDUCTIVE LOADS, REFERRING TO FIGS. 5 AND 6. FIG. 8. MESH-CONNECTED QUARTER-PHASE SYSTEM OF WINDING. FIG. 9. VECTOR RELATIONS IN MESH-CONNECTED SYSTEMS.

9 Eac = Eab + Ebc = $\sqrt{2}$ Eab, since Eab = Ebc and is displaced by 90°. The sum is here taken because Eab is measured towards the point b and Ebc away from this point. Thus, in a quarter-phase mesh-connected system the pressure between opposite wires = $\sqrt{2}$ times the phase pressure.

CURRENT RELATIONS. The line current, Ib, Fig. 9, measured toward the point b is the vector difference between the currents Ibc, measured from b, and Iab, measured toward b, by law I-b. In Fig. 9 the vector difference Ibc — Iab = Ib, gives a current $\sqrt{2}$ times Ibc and leading Ibc by 45°. Thus, the line current in a symmetrical quarter-phase mesh-connected system equals $\sqrt{2}$ times the phase current, the loads being balanced.

2. THREE-WIRE, TWO-PHASE SYSTEM.

This system, as shown in Fig. 10, may be considered as a part of the star-connected quarter-phase system, with two phases removed and common wire returning to point 0.

PRESSURE RELATIONS. The pressure Eab is, as in the quarter-phase star-connection, the difference, Eoa—Eob

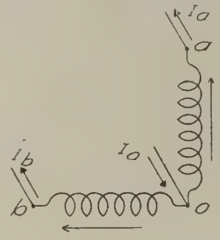


FIG. 10.

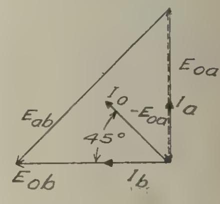


FIG. 11.

FIG. 10. TWO-PHASE, THREE-WIRE SYSTEM. FIG. 11. RELATIONS IN THREE-WIRE SYSTEM.

= $\sqrt{2}$ Eoa (see Fig. 11). It follows, then, that the pressure between outside wires = $\sqrt{2}$ times the phase pressure. The pressure between the common return wire and either outside wire = the phase pressure.

CURRENT RELATIONS. The current, Io, in the common return wire, measured toward the point O, is the vector sum of the currents Ioa and Iob, since each is measured away from the point, O. Since these currents are equal and displaced 90°, the current Ia, as shown in Fig. 11 = $\sqrt{2}$ times Ioa. Therefore, the current in the common return wire of a balanced three-wire, two-phase system = $\sqrt{2}$ times the current in the outside wires. As shown in Fig. 11, Io leads Eoa by 45°, lags 45° behind Eob and 90° behind Eab.

The next section of this article will take up 3-phase relations.

Conditions, Practice and Developments In English Central Stations.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)

BY CECIL TOONE, AN ENGLISH ELECTRICAL ENGINEER.

Section 3a. Characteristics of Engine Design.

THE salient characteristic of English engine building practice is widespread use of direct coupled high speed units. In this respect we differ radically from general European and American practice, and, as a result, obtain very compact generating sets, though probably at a somewhat higher maintenance and repair cost. It is largely owing to the development of the Willans (single acting) and Belliss (double acting) high speed engines that the English system has become practicable and has moreover been free from those operating difficulties which were reasonably predicted by many in earlier years.

Nevertheless this high speed tendency was not enforced without some opposition and in the early nineties there was the interesting spectacle in Taunton station of two Thomson Houston alternators belt driven from Willans engines. In early central stations, a countershaft was often driven by the engines through clutches or belts and thence the dynamos were driven by belting. Though enabling a very flexible interconnection of engines and generators, this system is of course long since obsolete. Direct coupling is now almost universal in English central stations, but a detailed consideration of this matter is postponed to Section 4, taking up generators, where the questions of common bedplates, armatures bolted direct to engine shaft flanges and so on, may appropriately be discussed.

The leading characteristics of various makes of engines show that single expansion engines are the exception in English stations (being seldom used for other than auxiliary sets), and that vertical enclosed engines are far more common than horizontal and open types. From a detailed analysis, along these lines of the engines employed in some 170 central stations in the United Kingdom the author has found that vertical, enclosed engines form about 80 per cent of the total here considered (210 engines), and that horizontal and open type engines are mainly confined to large, slow speed units. Compound expansion is usual,

though triple expansion is common in the larger units. In the latter case invariably, and in the former case usually, condensers are employed as shown in Table 5. In double or triple expansion engines, the cylinders are usually steam jacketed and reheating, by live steam coils, between cylinders is occasionally practiced. Jacketing is undoubtedly worth while where engines have to run for long periods on light load, but where superheated steam is employed and the engines run on three-quarter load or so for the greater part of their time in service, the efficiency is but little improved by jacketing.

Where two cranks are employed, these may be placed at 90 degrees or 180 degrees but in general with n cranks, these are often placed at rather less than 360° divided by n for balancing purposes. (Yarrow, Schlich and Tweedy system). The use of 160° crank angle (instead of 180°) sometimes simplifies the problem of transferring steam from one cylinder to the next. Much closer attention is now paid to balancing questions than has been customary in the past but it is often impracticable to prevent serious vibration in large reciprocating engine stations. On this account alone turbines are considerably more suitable than reciprocating engines for use in residential districts and near laboratories. Low speed engine units run at about 100 r. p. m.; small high speed units at from 400-500 r. p. m. and large high speed sets at from 200-250 r. p. m. Turbines usually run at from 1,000 to 1,800 r. p. m. The horsepower per revolution data is specially significant and interesting.

Broadly speaking, a higher piston speed means a cheaper engine but the internal friction and wear and tear due to reciprocating parts of given weight of course increases with the speed. Apart from balancing problems, the best piston speed varies roughly with the inverse of the square root of the weight of reciprocating parts. Tests carried out at the Armstrong College (Newcastle) in 1908, showed the maximum economy of steam to be reached with piston speeds of about 440 and 475 feet per min. in quadruple and triple expansion engines respectively; these figures naturally vary somewhat with the particular engine concerned.

In Section 9 on Buildings, considerable attention will have to be paid to the question of weight and floor space and volume occupied per horsepower by the various machinery of a central station. The superiority of high speed units, and in particular turbines, is obvious. The Parsons turbine sets at Dickson Street (Manchester) weight rather less than 0.2 times as much as the Musgrave reciprocating sets of equal capacity (3,600 kw.) and only 0.7 times the weight of the flywheels alone of the latter.

TABLE 5—ANALYSIS OF TYPES OF CONDENSERS AND COOLING ARRANGEMENTS IN 386 ENGLISH CENTRAL STATIONS.

Kilowatt Capacity of Undertaking—(1000 kw.)

Condensers, Cooling Arrangements, etc.	0–0.1	0.1–0.25	0.25–0.5		0.5–1		1–2½		2½–5		5–7½		7½–10		10–15		15–20	20–30		Totals
	Group L	L	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	L	M	
Surface	--	1	13	4	22	10	30	47	14	19	10	10	3	3	4	3	4	2	2	201
Ejector	1	4	6	--	13	5	4	18	4	7	--	3	1	1	1	--	1	1	--	68
Jet	--	4	5	--	8	8	5	14	3	4	1	5	1	3	--	2	1	--	--	64
Evaporative	--	1	--	--	4	1	2	4	3	--	1	--	1	--	--	--	--	--	--	17
Barometric	--	--	1	--	1	--	1	3	--	1	1	2	--	2	--	--	--	--	1	13
Canal, River or Well	--	2	10	1	15	5	6	22	12	5	2	1	--	--	1	--	--	--	--	82
Cooling Tower	--	--	4	1	4	6	14	15	3	8	4	6	1	2	1	1	2	--	1	73
Cooling Pond	--	1	--	--	4	2	2	3	--	2	--	--	1	--	--	--	--	--	--	15
Non-Condensing	15	31	17	--	17	5	3	3	1	2	--	--	--	1	--	--	--	--	--	95
Total Stations	16	41	43	4	60	24	39	66	17	25	11	12	5	5	4	4	5	3	2	386
Total Stations L and M	16	41	47		84		105		42		23		10		8		5	5		386

GOVERNORS AND GOVERNING METHODS.

Here again there is neither space nor necessity to enter into a detailed classification of the method and apparatus employed on various engines. Shaft governors are the most generally employed on high speed reciprocating engines (in the 145 stations referred to in the last paragraph, 85 per cent of the governors were of this type), various weight or spring loaded centrifugal governors being employed on slow speed sets. Where rope driven governors are used, steam is generally cut off automatically should the driving rope break. Throttle governing is generally the cheapest and simplest to fit and gives the best operating results on low loads, expansion governing is preferable where the engine runs for long periods on high loads and this system has the further advantage of giving steady speed with minimum flywheel capacity. The best results are obtained by fitting expansion gear to all the cylinders of multi-expansion engines, but it is very usual practice to equip the high pressure cylinder only with automatic expansion gear, leaving the low pressure cut-off to hand regulation by the engine driver. Many reciprocating engines and practically all turbines are fitted with emergency governors which shut off all steam supply should the speed exceed a predetermined safe limit. Again, a by-pass valve may be arranged to admit high pressure steam to the low pressure cylinder to prevent undue fall of speed on overload.

SPEED VARIATIONS AND FLYWHEELS.

Speed variations fall under two main headings—cyclical and permanent. It is unnecessary to dilate upon the genesis and effects of cyclical variations, they affect only a. c. sets operating in parallel but are then most important. Their prevention in an existent installation in which they give trouble is a most difficult matter and the presence of inertia, in a flywheel or elsewhere, merely emphasizes affairs, once hunting is set up. Cyclical variations should not be specified as variations in angular velocity but as degrees of phase displacement and a suitable limit to the latter (equals angular displacement $\times$ pairs of poles), is say 6 degrees, the higher the engine speed, the greater the permissible angular cyclic variation. To rapidly damp out hunting, a very sensitive governor is required, but on ordinary loads, a less delicate control is desirable, hence the introduction of by-pass dash-pots providing both species of control according to requirements. In turbines, the speed variations analogous to the cyclical changes of reciprocating engines are those set up by "gust" governing but in few cases do these lead to trouble. Where turbines and reciprocating engines operate in parallel, hunting and cross current difficulties are very frequently encountered. In

any case, all parallel prime movers should have equal speed drop on load.

Turning to "permanent" speed variations there occurs a transitory rise or fall in the speed of any prime mover on suddenly rejecting or accepting a heavy load. This transitory change is followed by a smaller and truly permanent speed variation (from the hitherto existing value). The temporary speed change on suddenly passing from zero to full load (or vice versa) should not exceed 5 per cent and may be restricted by the use of specially sensitive and powerful governors and by the use of heavy flywheels. The permanent variation of speed from zero to full load depends solely upon the accuracy of the governors employed, may vary from 1 to 3 or 5 per cent and generally averages 2½ per cent. Hand adjustments are usually provided whereby the normal speed of the engine may be varied over a 5 to 10 per cent or even 25 per cent range.

CONDENSING NOTES.

The increased output obtainable from a given engine by exhausting to a vacuum varying from 30 to 40 per cent or more, no further cause need be sought for the great predominance of condensing plant in present stations. The steam turbine is essentially suited to low initial pressures and very high vacua and since the commercial use of these prime movers, the whole question of condensing has assumed greatly enhanced importance.

Though about 75 per cent of English central stations employ at least some condensers, see Table 5, numerous undertakings are run only partially condensing. Usually it is the larger, later units which condense in such cases and in stations of group M (lighting and traction) it is not unusual to find the traction sets alone condensing. In general, the main generating units which are in constant service, exhaust to vacuum in all but the smallest central stations. Nevertheless, the cost of condensing water is a serious restriction in many towns and in at least one large undertaking (6,000 kw. capacity), the whole plant is run non condensing solely owing to the absence of sufficient water supply at a reasonable cost.

TYPES OF CONDENSERS EMPLOYED.

Brifly reviewing the relative merits of the chief types ofcondenser now in use: Surface condensers give a very pure condensate (in the Derby station the condenser discharge is actually used for filling the batteries) and enable a higher vacuum than other types. The temperature of the circulating water should not exceed 70 degrees Fah. and should preferably be about 60 degrees Fah., otherwise great difficulty is experienced in keeping the tubes clean enough to preserve the best possible vacuum. In case of emergency, surface condensers will give about 12 per cent increased condensation (over normal) under favorable conditions.

Jet and ejector condensers enable the best results when a limited supply of condensing water is available. If the condenser discharge is to be used for boiler feed, it is of course imperative that the cooling water contain no injurious constituents. With good circulating water at about 60 degrees Fah. and a requisite vacuum not higher than 1½ pounds per square inch, abs. the jet condenser is generally preferable to the surface type but for vacua higher than 1 pound per square inch abs. the surface condenser is quite the best available. Barometric condensers are largely used in town areas owing to the small space occupied and the excellent results obtainable. Atmospheric and evaporative condensers are also largely employed in towns where space is valuable and water supply expensive. These condensers are often located on the roof of the station or outbuildings and will yield 26 inches or higher vacuum on dry, breezy days; in damp, foggy weather, their capacity is much reduced.

Reference to Table 5, analyzing the types of condensers and circulating water cooling arrangements in 386 English central stations, shows surface condensers to be far the most popular type, jet and ejector types being used to about equal extents (each in about one-third as many undertakings as the surface type), and barometric and evaporative condensers only to a very limited extent.

Without discussing the principles of condenser design, it is interesting to note that among some 30 surface condensing plants, of various capacities, in English central stations, the condensing capacity, in pounds per hour per kilowatt output varied from 15 to 40 and averaged 27½ pounds. The square foot of tube area allowed per kw. capacity of generating unit varied from 1.4 to 4.0 and averaged 2½ square feet and the pounds per hour condensed per square foot of tube area varied from 8¼ to 12½ pounds and averaged 10½ pounds. Among a group of ejector condenser installations the condenser capacity per kilowatt varied from 35 to 80 pounds per hour.

ARRANGEMENT OF CONDENSER PLANT.

The two distinct arrangements of condensers which may be followed are: (a) Central condensers, common to a number of engines. (b) Separate condensers, one to each prime mover. Again, a central air pump plant may be employed or each condenser may have its own pumps driven independently or from the main engine served. In many undertakings of moderate capacity it is usual to find either one central condenser serving three or four generating units or one condenser per pair of engines in larger stations individual condensers are more common. Speaking broadly, jet and ejector condensers serve one engine each (in large Sulzer units, two jet condensers are often fitted to each engine), while evaporative or surface condensers serve one, two or four engines according to the size of the latter. Turbo sets have usually one surface condenser apiece, placed, together with the requisite pumps, immediately below the turbine in suitable archways in the foundations. Apart from questions of capital and operating cost, the individual condenser system, with independent engine or (better) motor drive, gives the best vacuum results. In most condensing systems, an atmospheric relief valve is fitted to enable non-condensing working during cleaning of the condensers or during cessation of circulating water supply or the occurrence of any breakdown.

CIRCULATING WATER SUPPLY.

Wherever possible, an unlimited supply of circulating water from a river or canal is sought and, where mud or debris is present, the water is drawn from large settling pumps through rotary or other suitable strainers. The pipe system is flushed out from time to time by temporarily reversing the direction of flow or by pumping back water from a storage tank in the station. The cost of town water supply is frequently prohibitive to its use for condensing purposes and many stations have found it profitable to sink their own artesian wells. A certain large London station collects rain water to help reduce its water bill. Wherever there is any risk of temporary failure of the circulating water supply, it is usual to provide storage tanks enabling

from 6 to 12 hours uninterrupted working under normal conditions.

Cooling towers are very frequently employed in this country, see Table 5 owing to the common difficulty of otherwise providing a sufficient supply of cool circulating water at reasonable cost. The tower is usually built of creosoted wood though, since 1905, steel structures have been considerably adopted in town areas. The hot condenser discharge is pumped up 20 to 40 feet and trickles down through a stack of brushwood or creosoted pitch pine laths into a reservoir over which the tower is built. A forced cooling draught is now often employed but, where natural draught is depended upon, from 30 to 50 feet of purely "chimney" tower is built above the actual cooling section.

The cooling effected by such towers varies largely with atmospheric conditions (as also does the evaporative loss); relying upon natural draught, from 25-35 degrees Fah. cooling is ordinarily secured but, with forced draught a considerably wider temperature range can be dealt with. Where space is not specially valuable, a large cooling tank or pond, with or without fountain sprays is frequently employed. The extent to which towers and ponds are used in this country is indicated in Table 5. It will be seen that some 20 per cent of the stations dealt with have canal, river or well water supply; in the former two cases, the circulating water is generally returned to the canal or river or run to waste but, where well supply obtains, cooling towers are frequently employed to reduce the cost of pumping.

Alternating Current Engineering.

(*Contributed Exclusively to* Southern Electrician.)

BY WILLIAM R. BOWKER.

Continued from Material in March Issue. Starting Methods for A. C. Motors With Coil-Wound Rotors.

With the coil wound rotor, high and variable starting torque can be obtained by inserting a variable ohmic resistance directly in the rotor circuit. Other things being equal, a rotor of high resistance provides high starting torque, but this is accompanied with an attendant sacrifice in slip and lower efficiency, both very undesirable practical conditions. The essential combinations of high starting torque, low starting current and high efficiency can be attained by inserting non inductive resistance in the rotor circuit at starting, which can be cut out as the rotor attains normal speed, therefore with low internal resistance in the rotor windings and proper facilities for short circuiting the windings after running up to full speed, the operating characteristics of the coil wound rotor type will practically equal those of the squirrel cage type.

In the short circuited squirrel cage rotor, the great weakness in practical operation is that there is no way of limiting the excessively abnormal currents of relatively low power factor which are induced in the low resistance bars of the winding and as these currents neutralize the self-induction of the stator windings, excessive and disturbing currents are drawn from the supply lines. The only way to prevent this would be to wind the coils of high resistance wire, which would of course increase the resistance and greatly decrease the efficiency, a condition practically and commercially undesirable and for these reasons not resorted to.

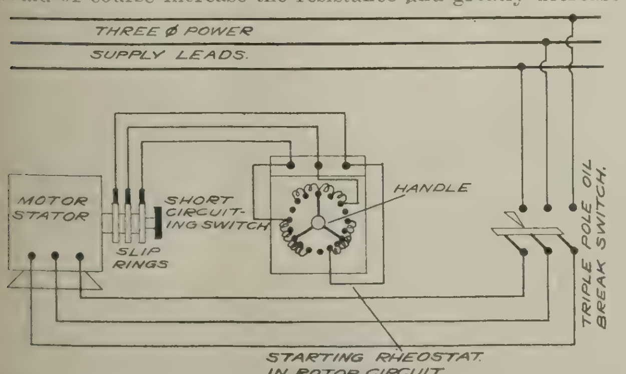


Fig. 69. Connections for 3-Phase Motor, Coil Wound Rotor.

The one practical and efficient alternative is to have a coil wound rotor, the windings of which are connected to slip rings and brushes. The rotor circuit is then connected to a non-inductive resistance, which can be varied and gradually cut out as the motor attains speed. Fig. 69 illustrates the connections of a three-phase motor with coil wound rotor connected to a three-phase circuit, in which there is a triple pole oil break switch with fuses or overload cut out relays inserted in the supply circuit leads that are connected to the stator terminals. In the rotor circuit is inserted a variable non-inductive resistance.

When in the extreme left hand position the resistance is out of circuit and likewise the rotor. To start the motor, current is first switched on to the stator circuit by the closing of a triple pole switch connected to the three-phase supply lines. The three-pole contact blades of the starting resistance are now moved over from the off position (XXX) on to the resistance studs, the first contacts of which places the whole of the resistance in circuit with the respective three-phase windings of the rotor. This prevents the current induced in the rotor windings by the stator circuit from reaching an excessive amount, and the motor now starts under load with all resistance in circuit. The switch handle on being further rotated in a right handed direction gradually cuts out the resistance until when reaching the contact studs (YYY) all the resistance is out of circuit, thus in this position short circuiting the rotor windings.

In starting, the handle of the rheostat switch should be moved slowly from contact to contact, allowing a sufficient time on each contact for the motor to attain its full speed. The interval of time, however, should not be longer than 30 seconds, since detrimental overheating of the rheostat would probably result. If the rotor is provided with a short circuiting device as shown, it should be inserted in circuit after the rheostat handle has been moved over to the last stud contact. The handle of the starting rheostat may then be returned to its starting position. It will be noticed that the starting resistance is not placed in the main line supply circuit, but only in the rotor circuit, which is acted upon inductively by the three-phase current

flowing in the stator circuit and itself directly connected to the three-phase supply. The rotor rheostat control by preventing an excessive current to flow in the rotor circuit, reacts inductively on the stator circuit and prevents an abnormal current flowing in the stator circuit. This mutual inductive action between the currents flowing in the stator and rotor windings makes it possible for the current to be controlled by inserting suitable starting devices either in the stator circuit or the rotor circuit.

To stop the motor, pull the main switch, after which the short circuiting device in the rotor circuit should be released and the rheostat handle returned to its off position. In this position its must always be previous to starting the motor. To reverse the direction of rotation of the rotor, interchange any pair of leads connected to the supply lines. It will be noticed in this description referring to Fig. 69, that the rotor windings are short circuited when the switch blades are on the contacts (YYY) that is all the ohmic resistance of the starting rheostat is out of circuit. If there were no additional short circuiting device, this would necessitate the brushes pressing upon the slip rings all the time that the rotor was rotating. The object and advantage of having the additional short circuiting device controlled by the switch located at the end of the rotor shaft, is that the brushes can be lifted from out of contact with the slip rings, a condition desirable in practice while the motor is running, especially for long periods of time and when motor is located in dusty locations, or where grit, dirt or frictional matter is liable to be deposited upon it. This is especially so where motors are used for power purposes in and around coal mines.

The short circuiting device also possess the advantage that frictional loss between the brushes and slip rings and also copper losses in the connecting leads are prevented and entirely eliminated. This is a consideration of importance when a motor has to run for long continuous periods.

In Fig. 70 is shown a diagram for connecting in circuit a 30 horsepower, 200 volts per phase, on a two-phase power supply. The rotor is coil wound with slip rings and in the circuit is a rotor starter rheostat connected as shown. Interposed in the two-phase supply and the stator windings there is placed a double pole single throw switch and fuses. A second form of rotor starter is shown at the right hand, the three terminals (XXX) connecting to the rotor slip rings in a manner similar to the other one.

To start the motor, close the stator circuit switch, then gradually move the rheostat handle from the rest position to the load position. To stop, pull the switch, and after the motor comes to rest, see that the rheostat starter is returned

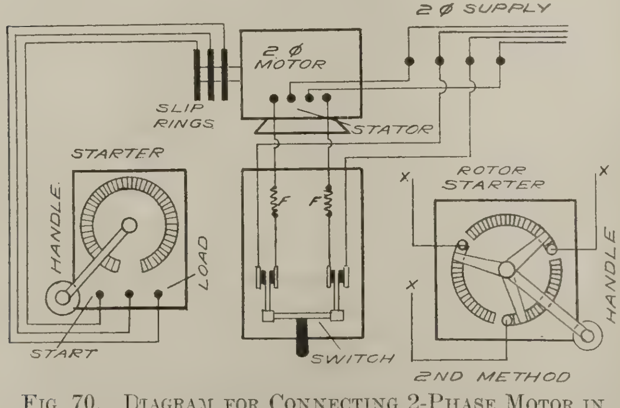


FIG. 70. DIAGRAM FOR CONNECTING 2-PHASE MOTOR IN CIRCUIT.

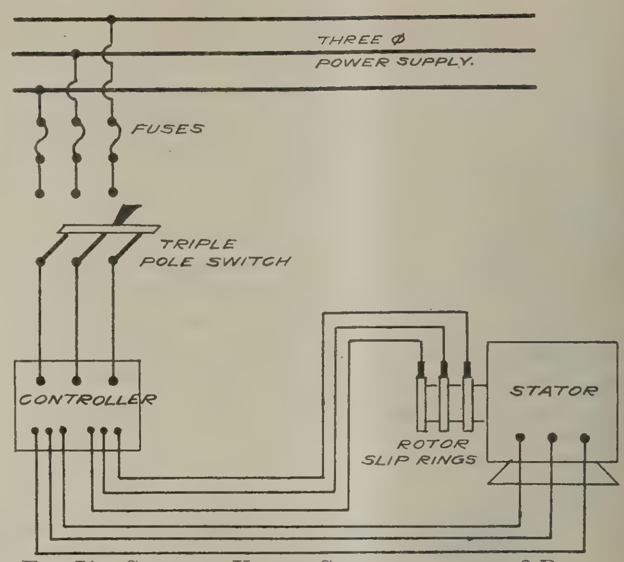


FIG. 71. SHOWING USE OF CONTROLLER WITH 3-PHASE MOTOR.

to its rest or start position. There is no metallic connection between the rotor and stator circuits, each winding being separate and distinct, the two circuits as previously explained, acting inductively.

In Fig. 71 is an outline of connections showing three-phase motor operated by means of a controller. A more detailed explanation of controllers will be given later on. The controller handle when located on the first contact puts the stator in circuit with the supply lines and afterwards puts the rotor in circuit with a starting resistance.

Officers of American Electric Railway Association Visit Southern Cities.

The officers of the American Electric Railway Association started April 17 on a trip from New York to the Pacific Coast and return, visiting on the way the following cities of the South: Between April 18th and May 1st, stops will be made at Richmond, Va.; Charleston, S. C.; Augusta, Ga.; Atlanta, Ga.; Nashville, Tenn.; Memphis, Tenn.; Birmingham, Ala.; Mobile, Ala.; New Orleans, La.; Galveston, Tex.; Dallas, Tex.; Oklahoma City, Okla. The trip will then continue to Los Angeles, Calif., and San Francisco, returning by a northern route. The purpose of the tour is to bring about a better understanding between electric railway companies and the communities which they serve.

The officials of the Association making the trip include Thomas N. McCarter, of Newark, N. J., president of the American Electric Railway Association and preseident of the Public Service Corporation of New Jersey; James H. McGraw, of New York, vice-president of the American Electric Railway Manufacturers' Association and president of the McGraw Publishing Company; W. L. Conwell, of New York, president of the American Electric Railway Manufacturers' Association; Charles C. Pierce, of Boston, member of the executive committee of the American Electric Railway Manufacturers' Association; H. C. Donecker, of New York, secretary-treasurer of the American Electric Railway Association.

While at Atlanta, Ga., April 22, several points of technical interest were visited. A reception was given at the Capital City Club by the officials of the Georgia Railway and Power Company, during which a sumptuous dinner was served. At this time Messrs. McCarter, Conwell and Pierce gave talks referring to the work of the Association.

Features in Design of a 30,000 K.W. Central Station.

BY IRVING E. MOULTROP, CONSULTING ENGINEER FOR EDISON ELECTRIC ILLUMINATING CO., OF BOSTON.

THE design of no two central stations under the present day variety of demands in different locations, is exactly the same, nor can this ever be hoped for. There are, however, general considerations which must be studied and which apply to all stations of the same size and class. In a lecture before the Stevens Engineering Society of Hoboken, New Jersey, Mr. Moultrop emphasized these considerations and outlined in an interesting way the design of a station such as found in our larger American cities. He referred especially to the design of the L Street station of the Edison Electric Illuminating Company of Boston, which is without a doubt typical of the best construction at the present time. An abstract of Mr. Moultrop's lecture follows:

In taking up the design of a central station, the first thing to be considered is the location. The location to my mind is strictly an engineering problem, but sometimes for good and sufficient reasons the engineer has to take a certain piece of property and make the best possible use of it. If the station is to supply low potential direct current the first consideration is to find a location which is conveniently accessible to the center of current distribution; in other words, the station must be adjacent to the area where the current is to be used as otherwise the fixed charges on the feeder installation and the energy losses in the feeders will become excessive. To-day it is general practice to generate high tension alternating current which enables the engineer to locate his station to the best possible advantage, and distribute the output without excessive cost over territory within a radius of a good many miles. We will, therefore, consider the requirements for an alternating current station.

DETERMINING A CENTRAL STATION LOCATION.

The chief considerations in the order of their importance are: Fuel supply; circulating water supply; cost of land; fuel storage space; room for growth of the station; boiler feed supply; and transmission line routes.

These will be taken up in detail. By fuel supply I do not mean so much the source of supply, but the methods and facilities for bringing the coal from its shipping point to the station. It must be borne in mind that the arrangement for obtaining coal must be such that there shall be no interruption to the coal supply as otherwise the station might have to shut down, which would entail not only loss of revenue for the period of shut down, but very likely the loss of valuable customers.

The second consideration is the circulating water supply, or the cooling water for the condensers. This ought to be almost unlimited because the quantity of cooling water required to maintain a high vacuum is enormous, especially when you consider that the temperature of the water in our rivers and in our harbors during the summer time gets quite close to the temperature of the vacuum it is desired to maintain. At the L Street Station of the Edison Electric Illuminating Co., of Boston, with six units installed, the condensers require 8,000,000 gallons per hour which is in excess of the daily water consumption of many of our cities. If the proposed station is inland where the only available water is from a small pond or stream, of course the only thing to do is to make the best possible use of the supply at hand, but a good sized station (by that I mean a station of 30,000 k. w. or over) to get the best operating economy should be located where there is a very large supply of water available. The water, if possible, should have a reasonable depth to avoid excessive temperature rise during the hot summer period; as for instance, it is very much better for a seashore station to take its water from a channel, where there is considerable depth and current at all times, than from an arm of the harbor where at low tide there is only a foot or two of water over the flats.

The cost of land I put down third in order of importance. I am not quite sure that it should rank even as high as this, because if all the other requirements are well satisfied quite an amount of latitude can be afforded in the cost of the real estate. Nevertheless, a large central station with all its adjuncts covers a considerable amount of space, and the cost of this land is a fixed annual charge on the station during its existence.

The fourth item is fuel storage space. If the coal is to be transported by railroads it is very essential to have at all times a considerable quantity of coal in storage to guard against labor troubles on the road, shortage of cars, and accidents of various kinds that might temporarily interfere with the supply. Where the coal is brought to the station by water there is less liability of interference with the delivery from the above mentioned causes, but a scarcity of vessels and severe storms will temporarily interfere. But whether the station is on the coast or inland a large storage space is very essential. Labor troubles and catastrophes at the mines may temporarily interfere with the regular supply of fuel. In my own opinion a central station should always have on hand a month's supply of fuel, and during the winter months, when most of our stations have their heaviest loads and when there is a greater liability of interruption to the transportation no matter whether by land or by sea, there should be at least three months' supply of fuel on hand. A few months' calculation will show you that, with average coal consumption, a station of 30,000 k. w. capacity will require considerable space for the storage of this amount of fuel if it is piled to a conservative height of fifteen to twenty feet.

The next requirement is room for growth. In some few instances the ultimate size of the station can be definitely settled at the same time the original plans are made, but in the majority of cases of which I have personal knowledge, the stations have grown to largely exceed the original plans. The rapid development in the use of electricity in this country has resulted in stations of enormous size and beyond the dreams of the optimist of a few years ago. Of course one can always go to a new location and build another station when the existing plant has reached its ultimate development, but when this is done some of the features of the original station have to be duplicated to a

certain extent, such as wharfage or railroad connections for fuel, coal handling machinery, and transmission lines. A new station calls for a new organization of operating people, whereas an addition to the existing station merely increases the working force. It is, therefore, oftentimes desirable to increase the original station buildings, and the original plans for the station should always be made so that this can be done conveniently.

The next item is boiler feed supply. One might think that this is just as essential as the fuel supply, and so it is in a way, but the quantity of boiler feed water is very much smaller, especially in a turbine station with surface condensers. So while it is just as important, it is a much simpler matter to make arrangements for. When a station of any size is being planned, the question of water supply for the boilers should be considered and the proper authorities consulted to make sure that the existing water mains will have sufficient capacity, and there should be more than one water main supplying the service to the station.

The last requirement is the transmission line routes. This is something which will in a measure take care of itself, but should not be entirely ignored. It is always advisable to avoid crossing navigable water with these lines and, if two locations of practically equal merit were under consideration, one of them entailing expensive underground construction for a considerable distance from the station, while the other one would only require cheap underground construction or possibly offer a good overhead right-of-way, the latter would offer some attraction from the investment standpoint. In any location there should be two or more good transmission line routes available.

THE DESIGN OF THE STATION.

Having determined on the location, the next thing is the design of the station itself. At this point several problems have to be considered together. One of the first things to get under way is the construction of the buildings, but naturally their size and details cannot be determined until the number and size of the prime movers is settled and the general arrangement of the station has been rather definitely fixed upon. The number and size of the prime movers is really the first thing that has to be settled and this is usually a question which calls for much thought. The determining features are the present size of the business, the probable future growth, and whether the station is to be backed up by, or connected with, some other station. It is, of course, desirable to have each prime mover as large as possible and the number as small as possible, but in deciding this question the minimum load on the station must be considered as well as the maximum in order that it shall not be necessary to operate a larger prime mover at a very uneconomical load during certain portions of the day or during certain portions of the year. The number and size should also be such that there will be a spare unit ready for service at all times, except perhaps for a very short period during the extreme peak load of the year. Even then, unless the station is backed up by another station, the number and size should be such that if one unit were suddenly taken out of service by an accident, there would be sufficient overload capacity on the others still to maintain proper service to the customers. Having determined the number and size of the prime movers, the next thing is to get them ordered because they are the things which it usually takes the longest time for the manufacturer to supply.

The next step is to decide on the number and size of the boilers. These remarks apply altogether to water-tube boilers, because I do not consider any other type of boiler suitable for the kind of station we are considering. In regard to the size of the boiler units, it has become almost standard practice in American power plants to use a boiler from five to seven hundred and fifty horse power. This size makes a very compact unit and one which is easily operated and kept clean. Some stations, on account of the high cost of real estate, or for some other reason which cramps them for room, have been using boilers running up to eight or nine hundred horse power capacity, but I personally question if this size is as satisfactory as the smaller one. Recently, or to be more exact, since the large turbine units have been manufactured some engineers have suggested or recommended very large boiler units, that is, of a size comparable to the turbine units. I have some doubt as to the advantages of these very large boiler units. They are more compact and, therefore, reduce the size of building and the amount of real estate required, but so far as I can learn they are no more economical in operation than the smaller ones, and the larger unit rather complicates the question of spare boiler capacity. The boiler to maintain good economy must be kept clean both inside and out, which entails taking the boiler out of service at frequent intervals. When the smaller sized unit is employed only a few additional boilers are required for spares, but when the larger unit is used, a very much greater percentage of the total boiler capacity of the station is taken out of commission when the boiler is to be cleaned, and any one of the numerous accidents which will suddenly put a small boiler out of commission will be just as liable to happen with the large unit with a very much more disastrous effect on the operation of the station. We will now assume that the number and size of the boilers have been determined upon and that they have been ordered, and will take up the next step which is the general scheme of installation or the arrangement of the apparatus.

While there have been a very large number of well-designed stations built in this country there is still a big field for an engineer to exercise his ability in working out the arrangement of his apparatus because a great many things have to be considered. In some cases the arrangement which will satisfy some of the requirements is not good for others. Generally speaking, the arrangement must be such that all pieces of apparatus are easily accessible for operation or repairs, the movements of material, such as coal, ashes, steam and water, must be as short and direct as possible, and the amount of traveling the operators have to do both vertically and horizontally must be reduced to a minimum. Daylight and ventilation are two important considerations, and I regret to say that they have been ignored to a large extent in many of our American stations. The two things that have to be handled in the largest quantities are the circulating water and the coal, and the vehicles for handling them are large and expensive. The design of the station should be such that water connections are short and direct, and that the coal can be brought either from the receiving point or the storage yard in the most direct way possible. While the ashes are only a fractional part as great in bulk as the coal they are more troublesome and disagreeable to handle, and suitable provisions must be made to properly take care of them. With the use of superheated steam the boilers must be brought as close as possible to the turbines to avoid excessive temperature drop and ex-

pensive and complicated piping. The switching is another very important consideration. It must have ample space allotted to it and be conveniently accessible to the prime movers, at the same time removed from the noise, confusion and dirt of the steam plant.

Having determined upon the general arrangement of the apparatus, the general design of the buildings is automatically settled because the chief function of the buildings is the housing of the apparatus. But one thing must always be borne in mind, the buildings should be amply large, so that not only is there plenty of space within them to operate and repair the apparatus, but they should be so built that it is always possible to increase the size of the units without serious complication. I know of two instances where within a few years the original installation of some steam turbines has been replaced with turbines of over twice the former capacity without increasing the size of the buildings. By that I mean the original units were taken out and units of over double their size were installed in the same place. Had the buildings been constructed to be a neat fit for the original installation it would have been impossible to have made the change without going to a far greater expense. Plenty of building space materially assists the ventilation of the station and also facilitates the distribution of natural light.

The type of building construction is another thing which offers considerable scope in its determination, and the location of the station and its environments must be considered in reaching a satisfactory decision on the type of architecture. There is one thing which every engineer should put down as the first principle of building construction for station purposes, that is, the building must be absolutely fireproof. By this I mean that when the building is completed and the station put in operation there should be nothing about the building structure or its equipment that is combustible. The exterior fire hazard must be as carefully considered and guarded against as the interior risk. The small amount of coal contained within the building should be so stored that it can be removed quickly in case it takes fire. Of more importance than this, however, is the proper handling of the oil. It is common practice to supply the principal bearings with oil under pressure from a central point. This center of supply holds a considerable quantity of oil and this should be isolated from the rest of the building and so arranged that it can be quickly drawn off in case it should become ingnited from some catastrophe.

The architecture should be of a substantial type and of a pleasing design. It should be an ornament to the neighborhood. Only within a few years has any consideration been given to this feature of central station construction in this country, but it costs very little additional money and the effect on the community is well worth the extra cost. The next section of this articlue will take up the details of the station.

Some Stages in the Development of Generator Field Regulators.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY GEO. J. KIRCHGASSER.

FOR most electric motor and lighting service the generator is required to supply current at a practically constant voltage. A change in the voltage of the supply for lighting purposes changes the candle power of the lamps, also variations in the voltage supply is a severe handicap in many motor applications. For large distributing systems, it is necessary to maintain within narrow limits the voltage at the various points of consumption, both near the generating station and far away. Field rheostats which vary the current of the shunt field of generators and thus change the field strength are used for regulating the voltage generated.

In the first generator installations, in which the units were of small size, the field regulating rheostat was also small and was usually mounted directly on the frame of the dynamo or near it. It was only called upon to dissipate a small amount of energy and consisted simply of a few coils of wire (only a few steps were required) connected to a suitable contact front. Also with the first installations it was not considered necessary to closely regulate the voltage. There was no objection to variations in voltage and lamp candlepower which would not be tolerated today. Each dynamo was run as a single unit and there were no problems dealing with the proper division of load on several generators operating on the same system in parallel.

When the time arrived for installing several generators in the same plant it was found inconvenient to have the various switches, regulating rheostats, etc., on each machine, and therefore these devices with meters were placed on a switchboard which made convenient the proper control of the several dynamos. The type of field rheostat shown in Figure 2 was developed and mounted directly on the front of switchboard. This type of rheostat as manufactured by the Cutler-Hammer Manufacturing Company, is still made for small or medium sized 75, 125, 250 and 500 volt dynamos and consists of a circular base plate of insulating material to which is attached the resistance wire, contacts and moving lever. A ventilated, japanned, iron case encloses the whole. Where the capacity of the dynamo was such as to require more rheostat capacity several of these were mounted on top of each other connected in parallel. But rheostats so arranged protruded considerably from the front of the board and the appearance was not the best. This same type of rheostat was next arranged for mounting on the rear of the board and operated by means of a hand wheel at front of board. The appearance of the switchboard was greatly improved.

As with the first generator frames which were frequently grounded, the first wire-coil field rheostats were also not well insulated. However the advent of the type of rheostat illustrated in Figure 2 and described above practi-

cally ended these troubles, as an insulating base was used and the enclosing case prevents direct contact with the heat radiating portion of the rheostat.

As the use of electricity increased, larger generators were built and a larger number installed in the large power stations. The distributed network of wires for supplying the consumers began to cover large areas and all this necessitated a closer regulation of the voltage. Field rheo-

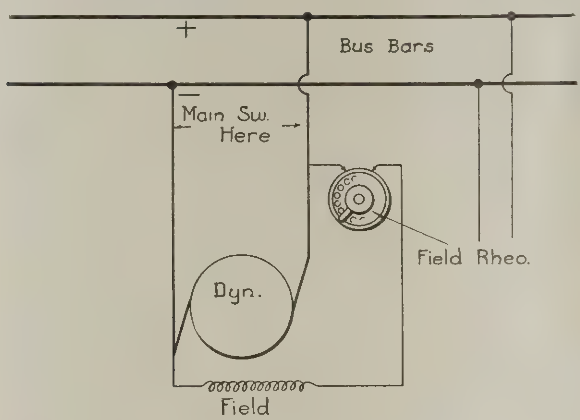


Fig. 1. Showing Connections for D. C. Generators and Field Rheostat.

stats had to be provided with more steps to give a finer regulation and units of larger capacities were demanded. The switchboard apparatus and connections became complex and complicated and in order to make room the rheostats were taken away from the rear of the panel and placed above or below and connected by means of chain, as shown in diagram Figure 3. The hand wheel for operation placed at a convenient height on the switchboard allows the operator to read the voltmeter when manipulating the handle. This dial-type of rheostat illustrated in Figure 4, consists of a slate panel on which a large number of renewable segments are placed. These segments are connected by asbestos covered wire to resistance grids mounted in rows in the frame behind the slate. The moving arm makes contact with the various segments and thereby varies the current in the shunt fields.

Modern practice requires generators of capacities up to 15,000 K. W. The energy which has to be dissipated in the corresponding field regulators is equally great, amounting in some cases to several hundred K. W., and it has, therefore, become a practice to build these regulators not in units as shown in Figure 2, but to make resistance of the cast iron grid type. The regulator front of these rheostats provides for a total of 60 to 120 steps (Figure 4 shows 104 steps) and as the current which has to be carried by

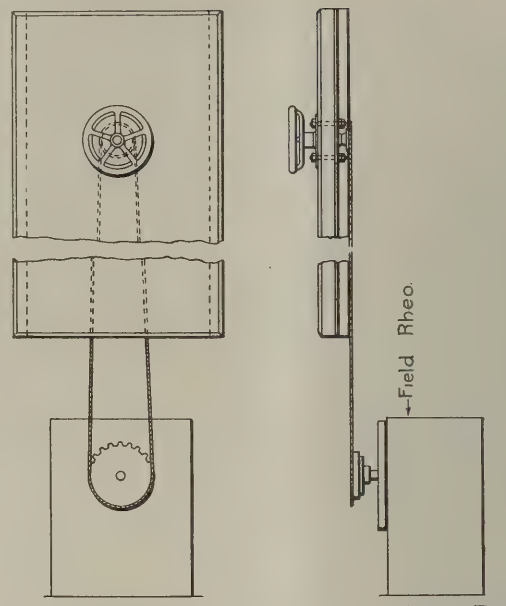


Fig. 3. Field Regulator Operated by Chain Drive.

the contacts amounts in some cases to several hundred amperes, the contact front is also equally large in size and it is not an easy matter for the operator to turn the lever by hand unless same is provided with a gear reduction. As stated above, the energy to be dissipated by the regulator amounts to several hundred K. W., and the resistance frame is therefore of very large dimensions. The heat generated by the rheostat is troublesome to the attendant in the generator room and on the switchboard gallery and as modern power stations are provided with a gallery above the generator floor where the space is very limited, it has become practice to install the field regulator in a separate well ventilated room, some distance away from the switchboard and control it remotely. The simplest means of doing this is by means of a sprocket wheel and chain, similar to the arrangement shown in Figure 3. Where the regulator room is some distance from the switchboard this sprocket wheel drive is not practical and motor-driven rheostats have been developed. The operation is by means of a small motor which may be controlled from a distance by a simple double pole knife blade reversing switch mounted on the switchboard.

As the earlier types of field regulators were all of the dial type it was only natural that the motor controlled regulator should be built along the same lines. It was, therefore, practice, as shown in Figure 7, to mount a worm gear on the control lever and drive this from the motor by means of a worm. An electric limit switch was provided

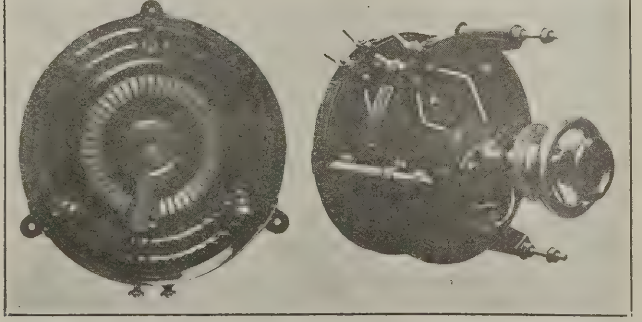


Fig. 2. Showing Wall or Front of Switchboard and Rear of Switchboard Types of Rheostats.

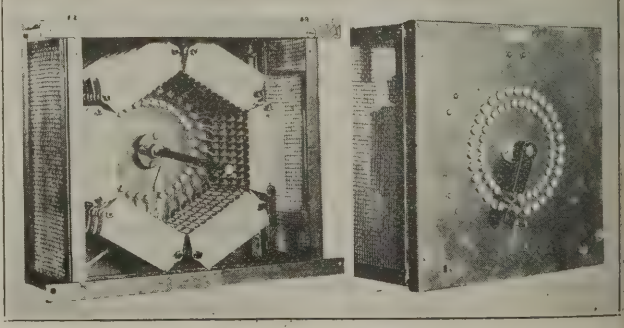


Fig. 4. Front and Rear of a Field Regulator Made up of Small X Type Cement Covered Units.

at either end of the travel of the contact arm which stopped the motor when all or no resistance was in circuit, so as to prevent jamming of the mechanical drive. This type of regulator has a great many disadvantages; one of them is the high gear reduction which is necessary and the large size of the dial type front for a certain current capacity. It is also very difficult to make the connections between the resistance and the front because the average distance is great and for field regulators of several hundred ampere capacity, the amount of copper for these connections is very great. Figure 6 shows another old type in which chain and sprocket wheel, motor-drive is used. Both have grid resistance.

To avoid these difficulties the crosshead type field regulator (Figures 8 and 9) was designed. The front for this apparatus is much more compact than that of the dial type and any current capacity can be provided for in a comparatively small space. The contacts which are connected to the various steps of resistance are mounted on two parallel slate bases which are supported by a cast iron frame. Brushes of suitable size make direct connection between two opposite plates; these brushes are carried on a casting provided with a suitable thread which engages with a shaft with square thread, this shaft being driven by means of spur gears of small reduction from the motor. Electric limit switches are provided at each end of the travel which cut out the motor if the brushes run to either limit. In order not to break any parts or jam the motor if these limit switches should fail to operate for any reason, the thread on the shaft has been cut away at the end of the travel so that the traveling nut will only move up to a

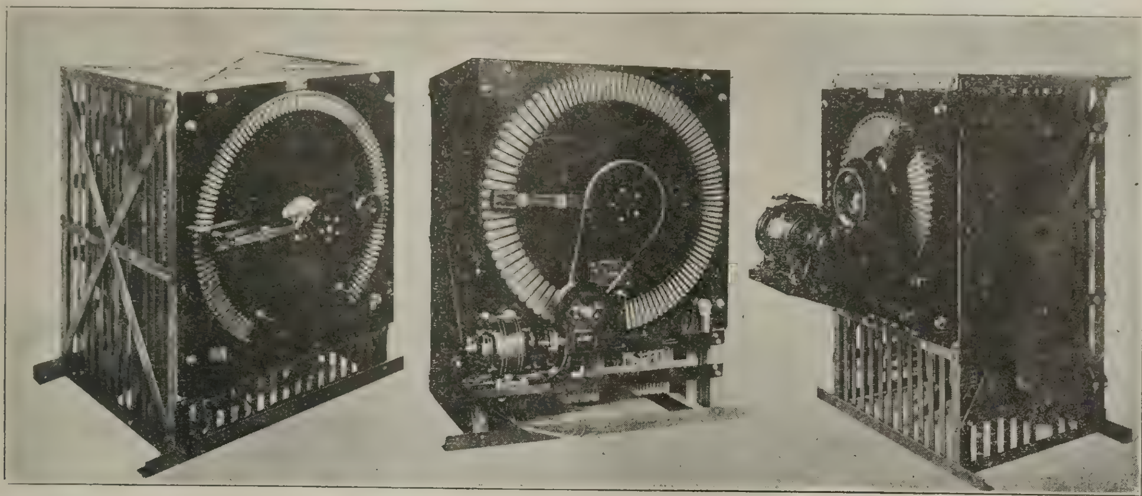


FIG. 5. LARGE CAPACITY DYNAMO FIELD REGULATOR EQUIPPED FOR OPERATION BY SPROCKET AND CHAIN USUALLY INSTALLED ABOVE OR BELOW SWITCHBOARD. FIG. 6. A SIMILAR REGULATOR MOTOR DRIVEN WITH WORM AND SPROCKET REDUCTION. FIG. 7. SHOWS MOTOR DRIVE WITH WORM GEAR AND GEAR REDUCTION. BOTH 6 AND 7 ARE FOR REMOTE CONTROL.

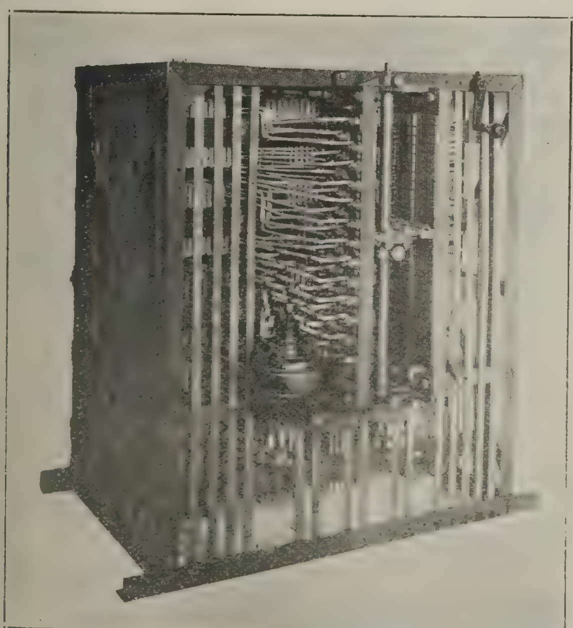


FIG. 8. CROSSHEAD TYPE OF GRID RESISTANCE FIELD REGULATOR MOTOR DRIVEN FOR REMOTE AUTOMATIC CONTROL.

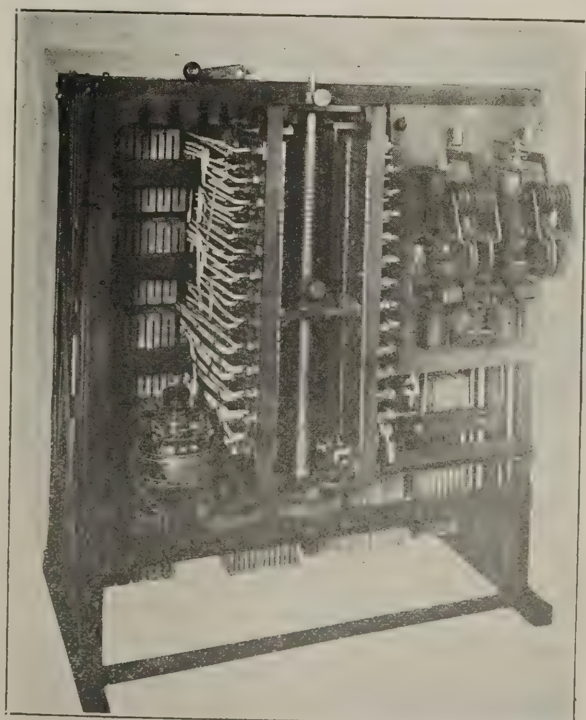


FIG. 9. SIMILAR TYPE TO FIG. 6, MOTOR DRIVEN WITH SOLENOID OPERATED FIELD CONTACT SWITCHES, ALSO FOR REMOTE CONTROL.

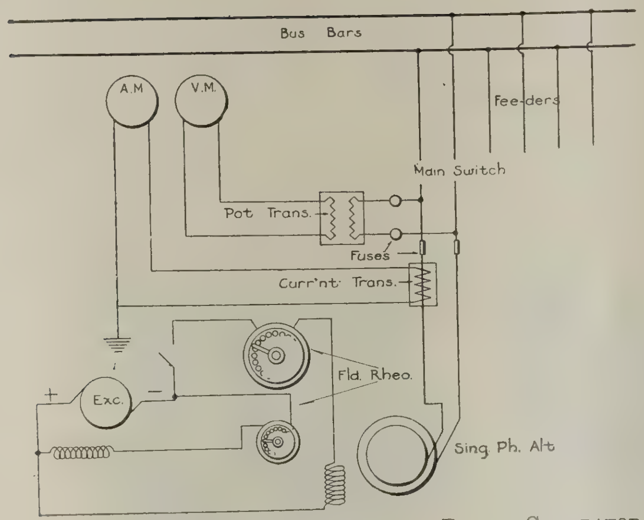


FIG. 10. CONNECTIONS FOR A SINGLE-PHASE GENERATOR, UPPER RHEOSTAT IN CIRCUIT OF ALTERNATOR FIELD; LOWER IN FIELD CIRCUIT OF EXCITER.

certain point where it is thrown out of engagement with the shaft. A spring presses the travelling nut against the end of the thread so that it becomes re-engaged when the direction of the motor is reversed. It is therefore not necessary for the operator to go back to the field regulator and bring the shaft and nut into engagement. The upper end of the shaft is also provided with a handle (see Figure 9) by means of which it is possible to regulate the apparatus by hand in case of trouble with the motor. This could not be accomplished so easily with the dial type motor-operated regulator on account of the high gear reduction and on account of the worm gear which is self-locking. On this latter type of apparatus it would be necessary to first throw the gears out of engagement before the contact lever could be operated by hand, while with the crosshead type regulator which has only spur gears it is possible to operate directly by hand and drive the motor through the spur gears. The crosshead type field regulator is also more compact than the dial type.

For alternating current generators, field rheostats are required for regulating the voltage of the exciter which provides the direct current for the field of the alternator and also for varying the strength of this field. The diagram, Figure 10, illustrates the method of connecting these rheostats for a single phase alternator. It is desirable to have the regulating rheostats placed near each other for convenient operation and the concentric type rheostat at right in Figure 2, is well adapted to its capacity for this service. One rheostat plate is operated by one handle and the other by the second, the rheostats and handles being insulated from each other. The inner handle is made of composition and the outer of copper similar to that used on other rear-of-board type rheostats previously described.

The field rheostat represents a small part of an electric plant installation, yet the review of the development in this line is but another indication of the marvelous growth of the whole electrical industry. Since the making of generators for 25 to 50 lamps there has been a steady development up to the generator capable of supplying a half million lamps. An advance in one apparatus requiring changes and new designs in the supplementary or auxiliary apparatus.

Some Cost Data on Steam-Electric Power Plants.

BY O. S. LYFORD, JR., AND R. W. STOVEL, CONSULTING ENGINEERS.

IN view of the fact that a study of costs is the key to the design of a power plant, whatever be its purpose, we believe what follows will be of interest from the standpoint of steam electric plants where the steam turbine is employed and bituminous coal used as fuel. This material is the result of a careful investigation by two experienced engineers whose names are given in the title, and is abstracted from a paper which they jointly presented before the Engineers' Society of Western Pennsylvania.

Irrespective of whether a power plant is to be used for a coal mine, a public service utility or a factory, the most important conditions which govern the design and construction are as follows: (1). Character of load to be carried. (High or low load factor, steady of fluctuating.) (2) Location of plant with reference to fuel and water supply. (3) Local conditions affecting the dimensions of the building and the construction of foundations and flumes. (4) Relative costs of available material and apparatus. (5) Fitness of various types of apparatus to the duty to be performed. (6) Costs of fuel and water. (7) Proper relation between operating costs and fixed charges, under the conditions imposed. Finally, there is the element of personal preference of the client, which is the deciding factor in the selection between types or methods that may cost practically the same and are economically equivalent.

The unit generally used in comparing plant costs is the kilowatt capacity of the generators installed. As there is today some little confusion in defining the rating of large generators, attention is called particularly to the fact that the figures given are based on the maximum continuous capacity of the generator or the output that the machine will give with a temperature rise not exceeding 50 degrees C. above the surrounding air temperature.

TABLE I—COST OF STEAM TURBO-ELECTRIC GENERATING STATIONS.

From 2,000 to 20,000 kilowatts capacity, based on maximum continuous capacity of generators at 50 degrees C. rise.

	Dollars Per KW High	Low
Preparing Site—Dismantling and removing structures from site, making construction roads, tracks, etc.	$00.25	$00.00
Yard Work—Intake and discharge flumes for condensing water, railway siding, grading, fencing sidewalks, etc.	2.50	1.00
Foundations—Including foundations for building, stacks and machinery, excavation, piling, waterproofing, etc.	6.00	1.00
Building—Including frame, walls, floors, roofs, windows and doors, coal bunker, etc., but exclusive of foundations, heating, plumbing and lighting	12.00	4.00
Boiler Room Equipment—Including boilers, stokers, flues, stacks, feed-pumps, feed-water heater, economizers, mechanical draft and all piping and pipe covering for entire station except condenser water piping	24.00	12.00

Turbine Room Equipment—Including steam turbines and generators, condensers with condenser auxiliaries and condensing water piping, oiling system, etc.	22.00	12.00
Electrical Switching Equipment—Including exciters of all kinds, masonry switch structure with all switchboards, switches, instruments, etc., and all wiring except for building lighting	5.00	2.00
Service Equipment—Such as cranes, lighting, heating, plumbing, fire protection, compressed air, furniture, permanent tools, coal and ash handling machinery, etc., etc.	5.00	2.50
Starting Up—Labor, fuel and supplies for getting plant ready to carry useful load	1.00	0.50
General Charges—Such as Engineering, Purchasing, Supervision, Clerical Work, Construction Plant and Supplies, Watchmen, Cleaning Up, etc., etc.	6.00	3.00
Total cost of plant, except land and interest during construction	$83.75	$38.00

Table I shows probable limits of cost of stations of the class referred to, namely, steam turbine driven, electric stations for all purposes, using bituminous coal for fuel and having no other equipment in them except that necessary to generate alternating electric current efficiently.

Some of the group costs in Table I do not have any very specific relation to the kilowatt capacity installed in the plant and the probable range in such costs is a matter of experience with previous cases. This refers to such groups as "Preparing Site," "Yard Work," Electrical Switching Equipment" and "Service Equipment." For instance, the main item of cost coming under the "Yard" group is generally that of condensing water flumes exterior to the building and it will be readily understood that this cost is affected much more by the relative location of the building to the water supply and by the character of work required than by the actual size of the plant. Similarly the electrical switching equipment costs depend much more on the extent and the scope of the electrical distributing system than upon the actual capacity of the plant. Again the largest item of the "Service Equipment" costs, namely, that of coal handling, depends upon the existing physical conditions much more than upon the capacity. Some of these cost groups, however, can be reduced to other units than that of the kilowatt, and this permits a clearer understanding of their range.

The foundation costs, for instance, will run from $1.25 to $4.00 per sq. ft. of building plan area, depending on the character of the soil; the lower cost covering simple concrete footings on thoroughly good bearing soil, while the necessity for piling, waterproofing, excessive rock excavation, etc., will run this cost toward the higher limit. Then the plan area will vary from 0.8 to 1.5 sq. ft. for each kilowatt of capacity installed, depending upon the size of the units and upon their arrangement; the combined effect of these two cost ranges giving the range in price per kilowatt shown in the Table. The building costs will vary from 8 to 12 cents per cu. ft. of overall building volume, according to the size of the building, the character of construction and the local price of building materials and labor. Depending again upon the size of the units and upon the efficiency used in arranging them, there will be required from 50 to 100 cu. ft. of volume per kilowatt of capacity. The combined effect is to make the building costs range from $4.00 to $12.00 per kilowatt. In boiler room equipment the cost of materials and labor will generally be between $30 and $40 per nominal boiler horse power, and generally there will be installed between 0.4 and 0.6 boiler horse-power per kilowatt of capacity, resulting in the cost range shown in the table.

LOCATION OF PLANT.

The actual cost of real estate makes practically no difference in design in the very large majority of cases; for, as a general proposition, it may be said that if sufficient room is allowed around the apparatus for its proper operation and maintenance, no material benefit can be obtained by spreading the apparatus over more territory. On the other hand, the location with reference to fuel and water supply and the physical condition of the property do very materially affect the cost, much more so indeed than any other one factor, except possibly the proportioning and arrangement of the apparatus. It is practically essential for any power plant of moderate or large size that the property have rail connections for the delivery of coal. It is also essential that there be an ample supply of condensing water, though cooling towers may be used with increased first cost and decreased economy. In the consideration of alternate sites, the cost of the "Yard Work" may have an important bearing.

PLANT FOUNDATIONS.

The condensing apparatus can only be placed a definite height above the extreme lowest level of the condensing water supply. This alone determines the basement floor level and, if in flood stages the water rises sufficiently to endanger apparatus at this level, more or less expensive costs are involved in the proper protection of the apparatus. The bearing value of the soil largely affects the cost, as the necessity for piling under all foundations or the necessity for large rock excavation instead of good bearing soil at suitable level, will increase the cost two or three dollars per kilowatt.

COST OF BUILDING.

The cost of the building is dependent upon the character of the structure which it is desirable to erect to be in keeping with the location and with other property of the operating company; but this cost depends much more on the efficiency in design and the proper arrangement and spacing of the apparatus. With a fortunate size and arrangement of apparatus only 50 cu. ft. of building volume may be required per kilowatt, while with a disadvantageous size of apparatus and with less regard being paid to an economical arrangement as much as 100 cu. ft. often results.

TURBINE ROOM EQUIPMENT.

The cost of the turbine room equipment depends mostly upon the size and speed of the main generating units. Naturally, the higher the speeds the less the first cost of the apparatus. Units of 2000 kilowatts and less are now considered practicable with speeds of 3600 r. p. m., whereas the larger sizes run at 1500 or 1800 r. p. m. Another factor affecting the costs of the turbine room equipment is the type of condenser selected. Condensers can be divided into two classes, first the surface condenser in which the condensing water does not come in contact with the condensed steam; and second, the mixing condenser in which the condensing water and the products of condensation mingle.

As a surface condenser installation will cost from $1.00 to $3.00 a kilowatt more than the mixing type, the warrant for it must be thoroughly established. The selection between these two types of condensers depends upon whether or not the supply of condensing water is suitable for feed-water, as if it is possible, there is no good reason for the surface type. If the condensing water supply is not suitable for feed-water, it is then a question of whether or not

the surface condenser saves enough in the cost of feed-water to warrant its greater first cost. As a very general statement, if the cost of feed-water does not exceed six cents per 1000 gallons; and if the average load on the plant does not exceed one-half the maximum load, then surface condensers are not warranted.

Formerly with reciprocating engines, it was possible to decrease the first cost of a station when its fuel economy was not essential or particularly when used only as a stand-by plant, by omitting the condensing apparatus. A steam turbine, however, takes about 50 to 75 per cent more steam when running non-condensing than condensing, and the first cost of providing the extra boiler capacity to run the unit non-condensing is generally much greater than the cost of the condenser with the necessary flumes for supply and discharge of cooling water. This results in the peculiar condition that a non-condensing turbine plant not only will cost more to operate, but will actually have an equal or greater first cost: In other words, a non-condensing station is no longer commercially feasible, except, of course, where there is a large requirement of exhaust steam for heating.

BOILER ROOM EQUIPMENT.

Considering now in detail the question of boiler room equipment, Table II shows a probable high and low range of costs for this group of apparatus.

TABLE II—BOILER ROOM EQUIPMENT COSTS PER RATED BOILER HORSEPOWER; USING COAL FOR FUEL.

	Dollars Per H.P. High	Low
Boilers exclusive of masonry setting	$11.00	$ 8.00
Superheaters	3.00	0
Stokers	5.50	3.00
Masonry settings for boilers	3.50	2.00
Flues	1.50	0.75
Stacks	4.00	2.00
Economizers	4.00	0
Mechanical Draft	3.00	0
Feed-Pumps	1.50	0.50
Feed-Heaters	1.00	0.40
All Piping and Pipe Covering	10.00	6.00
Coal Chutes and Ash Hoppers	1.25	0
Various, such as Indicating and Recording Devices, Damper Regulator, Ladders and Runways, Painting, etc., etc.	1.00	0.50
Totals	$50.25	$23.15

Note—The above costs are for labor and material only. They do not include any "General Charges" such as Engineering or Supervision. The piping item includes all piping in the entire plant except condenser water piping.

The unit costs in Table II are related to rated boiler horsepower instead of the kilowatt as used in Table I, as these costs vary almost directly with the rating of the boilers. With a given cost per horse-power for this boiler room group, the cost per kilowatt will vary according to the proportioning of the boiler capacity to the generator capacity. This proportion is the most important single question in power station design that is subject only to the judgment of the designing engineer. Considering the boilers themselves, there seems to be a decided tendency to use as large units as have been shown to be commercially satisfactory. This has practically resulted from the development of the steam turbine in large units. There is every incentive from the standpoint of first cost to reduce the number of boilers to the minimum that will meet operating requirements, and therefore to make each boiler unit as large as practicable. This is done at a slight gain of economy, although first cost and not economy is the principal motive. Boiler units of about 600 horse-power each are common practice. Much larger boilers have been installed in a few cases, and the results to date are very promising.

In addition to using larger units, there is also a decided tendency to make a given amount of boiler surface develop more power. Many years ago it was defined that 10 sq. ft. of heating surface should constitute one horse-power in the rating of a boiler. With the gradual development of mechanical stokers and our greater knowledge of the laws governing the efficient combustion of coal, it is quite practicable to obtain one and a half, or even two horse-power from this same surface. In other words, it is now customary to demand from boilers at least 150 per cent of their rating; and frequently 200 per cent. As the boiler plant must be large enough to supply the maximum demand for steam, it will be seen that if we plan to work the boilers 200 per cent of their rating at such times of maximum demand, we have practically cut in half the boiler group costs compared with former conditions. The use of superheat ranging from 100 to 150 degrees, F., will improve the overall fuel efficiency of the plant from five to seven per cent; and superheaters will generally result in an overall economy even with coal as low as $1.50 per ton.

Economizers have two uses; economy of heat, and heat storage. In general, it may be stated roughly that with 50 per cent annual load factor and coal costing $3.00 or more per ton, the saving in heat with economizers, is enough to more than cover their fixed charges and maintenance. These conditions may vary 20 per cent and the economizers still show an annual saving. The advantage of heat storage often justifies their use irrespective of the price of fuel. With a rapidly fluctuating load, the economizers aid the boilers in meeting sudden demands.

With the increased boiler pressures and superheat, and particularly with turbines taking steam continuously instead of intermittently, as with the reciprocating engines, there has naturally followed a decrease in pipe sizes. Whereas, formerly an eight-inch pipe would be used on a 500 hp. boiler running not much over rating, a six inch pipe is now used on a 600 hp. boiler and 1200 hp. taken through it. An important feature of steam piping is the pipe covering. Frequently the active competition between manufacturers leads to the use of inadequate covering. It pays to provide a good covering, well protected and so put together that it may be removed and replaced at small cost where necessary for repairs and adjustment of pipe joints and valves.

Table III has been prepared to indicate the range of common practice in coal consumption. Pittsburgh coal of 14,000 B. t. u.'s per pound is assumed for both cases. The annual average boiler and furnace efficiency will range from 50 to 70 per cent, depending on the nature of the load the suitability of the station design to this load, and the efficiency of the operating force. Therefore, for each pound of coal burned, the B. t. u.'s made effective in the steam range from 7,000 to 9,800.

TABLE III—SUMMARY OF OPERATING RESULTS.

	Range of Common Practice	
British thermal units per pound of fuel (assumed)	14,000	
Average yearly overall boiler and furnace efficiency per cent.	50	70
Effective British thermal units per pound of fuel	7,000	9,800
Boiler pressure, pounds per square inch, gauge	125	190
Superheat, degrees Fahrenheit	0	125
Average feed-water temperature, degrees F.	120	200
British thermal units per pound of steam (approximate)	1,100	1,100
Pounds of water evaporated per pound of fuel, actual	6.36	8.91
Pounds of fuel per standard boiler hp. (33,305 B. t. u's.)	4.76	3.40
Average overall station water rate per kw.	30	20
Pounds of coal per kw. generated	4.72	2.25
British thermal units in coal per kw. generated	66,000	31,500
Thermal efficiency of station, percent	5.2	10.8

Considering next the condition of the water and steam, the boiler pressure may be anything between 125 and 190

lb. In many cases no superheat is used, and in a steam turbine station where the conditions warrant it 125 degrees of superheat may be used. The temperature of the feed-water entering the boiler ordinarily varies between 120 and 200 deg. F. These conditions of boiler pressure, superheat and feed-water temperatures may vary in an actual station more than the limits here shown; but the interesting thing is that the combination assumed for the two extremes result in the same number of B. t. u.'s per pound of steam. The explanation for this lies in the relative temperatures of the feed-water. The additional heat necessary to bring the temperatures of the feed-water of the one case up to that of the other, is enough to raise the steam pressure in the second case to 65 lb. above the first and to superheat the steam 125 deg. The steam in the second case will do ten per cent more useful work than the steam in the first case. The importance of proper feed-water heating is apparent.

The combination of the figures in the third line and the seventh line results in those of the eighth line, so that the pounds of water evaporated per pound of fuel varies between 6.36 and 8.91. Experience has shown that the average annual water rate of such stations, including the main units and all auxiliaries, varies between 30 and 20 lb. per kw.-hr. These figures divided by the rate of evaporation, give the figures in the next line for pounds of coal per kilowatt-hour generated. These figures in turn multiplied by 14,000, give the B. t. u.'s in the fuel per kilowatt-hour generated, these being average figures for the entire year. A kilowatt-hour is theoretically equivalent to 3,420 B. t. u's. Therefore, the annual thermal efficiency of the station may vary between 5.2 and 10.8 per cent. In other words, one station may require more than twice the coal per kilowatt-hour per annum as another, even though both are condensing stations operated under conditions within the range of common practice.

Better overall results than the best here shown have been obtained for months at a time, if not years, but these have been cases of particularly large stations or exceptionally good load factors, and it is not often the combination of conditions permits present day apparatus to exceed the high figure here shown. On the other hand, many power plants do not get even as good results as the lowest in the Table. In many cases this is logically due to the small size of the plant or the character of the load, but in some cases it is due to improper design, and in many cases the poor results are due to lack of supervision and knowledge on the part of the operating force.

In conclusion, therefore, the principal points which we wish to make are: (1) A conventional power station design generally adaptable to a given class of service, is not practicable. (2) Geographical location, in itself, should have no bearing on the design of a power station. (3) The location with reference to fuel and water supply and the physical condition of the property, however, have a very important bearing on the cost. (4) The cost of real estate in a large majority of cases has little to do with the design of a power plant. There is small difference between the area that will give sufficient clearances, and the minimum on which the apparatus could be placed. As between two possible sites the costs to be equated against real estate are mostly in the intake and discharge flumes and the coal handling facilities outside the power house. (5) Ornamentation of a power station building to suit local conditions need not add greatly to the cost.

Effective Electrical Inspection and How to Secure It.

(*Contributed Exclusively to* Southern Electrician.)

By W. J. Canada, Electrical Engineer for Rocky Mountain Fire Underwriters Association.

Electrical inspection is first of all the result of an active demand for uniformity of construction. Some wiring contractors will be found, who on some buildings will without inspection produce safe and permanent wiring. Competition, however, will soon make wiring frail and dangerous, the more so, as the purchaser is unable of his own knowledge to discriminate as he can with most forms of construction. Fires, continued troubles with lights, or the criticisms of fire hazard by insurance raters, ultimately create a partial demand for an inspection which will obviate these troubles.

A standard is now available, but has no legal status. The insurance engineer advises and criticises, but his statements have no legal effect, and installations may still vary as the owner or workman decides. By specification much can be done, but the changes and additions can be covered only by recurring inspections which owner or management may or may not demand. A legal standard must be developed, it must be made unlawful for other than licensed and bonded wiremen to interfere with wiring, and a legal inspection must be arranged. Supply stocks must be pruned of defective wire and fittings. Finally inspection and enforcement must be removed from adverse political influences as far as possible, and competency of the inspector insured by disinterested support.

This whole process is the peculiar field of the underwriters, whose interest is solely for safety and permanence. The standard may be secured by passage of ordinances, and ultimately by statute, including the requirements of the National Electrical Code, with such additions as the best practice indicates, among them the extension of conduit wiring over continually broader limits, the use of cabinets for cut-outs in all cases, and the abolishment of certain more objectionable classes of construction. Rules for motor fusing may be made more definite, and the discretionary powers of inspector confined to interpretation rather than extended to individual rulings.

The licensing of contractors and wiremen will become a part of ordinance or statute. The supervision of detail in inspection, grade of results, etc., should be made by underwriters periodically at least. An arrangement for such aid and supervision is easily made with any municipality in these days of publicity, as the specializing on fire prevention should evidently give the fullest competency to underwriters' engineers, and the absence of local bias in the underwriters' inspection, will tend to recommend its utilization by even the purely political inspection department as evidence of its impartial enforcement of restrictions. Stocks may be made and kept free from objectionable materials by united action by municipal and underwriters' inspectors. Contractors may be licensed after examinations conducted by both interests jointly.

All the results outlined above follow naturally a comprehensive and forcible presentation of the subject to the law enforcers—the citizens. The most effective method is

for the underwriters' engineer to arrange a meeting with the commercial body, give a consecutive argument to them, answer questions, produce figures, and impart the impression of mutual interest in permanently safe construction. This body after due discussion, since it usually supports any measure calculated to benefit the community, will recommend action to the council.

It is ordinarily best to present a tentative ordinance to the city council, with the endorsement of the commercial association. A committee to consider the subject can then be advised on the most vital features of requirement, and the detail of form, penalty, choice of inspector, method of licensing, etc., left to the city attorney who will accommodate them to the uniform procedure of the city. The matter by this time will have become of vital interest to the public mind, and the enforcement of requirements will be given active support instead of suspicious and reluctant support by both property owners and tenants.

In a certain field covering several states, the pursuit of such a campaign has lately resulted in the adoption of twenty-one electrical ordinances, including two requiring all conduit in fire limits, the use of grounded secondaries in thirty-nine cities, the adoption of four gasolene lighting ordinances. For this twenty-seven complete city electrical reports were made, twenty-two commercial organizations and nineteen city councils addressed. Forty-three rough drafts of electrical ordinances were presented to city attorneys.

Along with such work must be handled the individual electrical inspections of buildings, which are the basis of the entire matter by developing the fire hazards in existing installations, and the frailty of all but standard forms of material and construction. Upon the proper balance between these duties, depends the greater or less success of the underwriters' engineer in the reduction of fire hazard and the advance toward wiring installations of equal permanency with other portions of building construction.

A Discussion of Rule 23d, National Electrical Code, Referring to 3-Wire Edison and 3-Phase Systems.

BY J. N. ELEY BEFORE ATLANTA SECTION A. I. E. E.

In accordance with the announcement made on page 155 of the April issue, we present herewith the paper by Mr. J. N. Eley, Consulting Engineer, of Atlanta, presented at the March meeting of the Atlanta Section of the A. I. E. E. In presenting this material Mr. Eley stated that he hesitated to dignify the discussion by the term of "a paper," yet he stated that to his own knowledge, the subject has proven a stumbling block to practical men in the construction field. The discussion deals in the main with Rule 23d, of the 1911 edition of the National Electrical Code, and indeed forms a subject of more than passing interest. The rule and Mr. Eley's remarks follow:

RULE 23.—AUTOMATIC CUT-OUTS.

d. Must be placed so that no set of incandescent lamps requiring more than 660 watts, whether grouped on one fixtures or on several fixtures or pendants, will be dependent upon one cut-out.

Special permission may be given in writing by the Inspection Department having jurisdiction, for departure from this rule, in the case of large chandeliers. (For exceptions see rule on Theater Wiring). All branches or taps from any three wire system which are directly connected to lamp sockets or other translating devices, must be run as two wire circuits if the fuses are omitted in the neutral, or if the difference of potential between the outside wires is over 250 volts, and both wires of such branch or tap circuits must be protected by proper fuses.

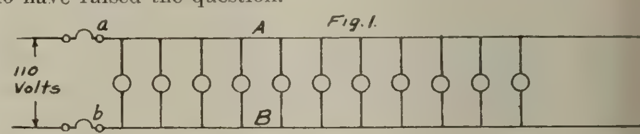
The above shall also apply to motors, except that small motors may be grouped under the protection of a single set of fuses, provided the rated capacity of the fuses does not exceed 6 amperes.

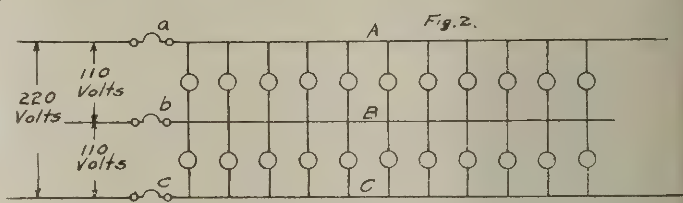
The fuses in the branch cut-outs, except for motors as noted above, must not have a rated capacity greater than that given as follows for circuits at various potentials.

55 volts or less	12 amperes
Over 55 but less than 125 volts	6 amperes
125 to 250 volts	3 amperes

For sign and outline wiring supplied by circuits of 55 volts or less, branch circuit fuses of 25 amperes capacity may be used.

A careful study of the foregoing reveals the limiting feature of any branch circuit of 110 volts, approximately as a 6 ampere fuse. Questions have, however, been raised and referred to the writer on this point by men actually and actively engaged in the installation and operation of wiring systems, and it may be of interest to present wherein the apparent difficulty lies. Therefore, we will look at the matter, as nearly as possible, from the standpoint of those who have raised the question.





FIGS. 1 AND 2. 2-WIRE AND 3-WIRE EDISON SYSTEMS.

Figure 1 illustrates the simplest form of a two wire branch circuit. Assuming a potential difference between A and B of 110 volts and the use of 11-60 watt Tungsten lamps we have directly the maximum allowable load, or 660 watts. The circuit is protected by a double pole cut-out with fuses *a* and *b*. The current, then, all lamps burning, is,

$$W/E = 660/110 = 6 \text{ amperes.}$$

Figure 2 illustrates the simplest form of an Edison 3-wire circuit, assuming 110 volts difference of potential between A and B and between B and C, and 220 volts between A and C. Again we assume the use of 11-60 watt lamps between any two wires of 110 volts difference of potential. This circuit is protected by a triple pole fuse block with fuses *a*, *b*, *c*. As before, each fuse will have a normal capacity of 6 amperes.

An Edison circuit is but a combination of two two-wire circuits, in that only three wires and three fuses are used, instead of four, and that the potential between outside wires is doubled. It is also clear that a combination of the sources of current supply is made in a similar manner on the other side of the cut-out—the middle wire being led out from the junction of the sources. So long as an equal

number of lamps (in the case under consideration) on each side of the Edison system are in service, "a balance" obtains, and no current flows in the wire B. In fact, under these conditions, fuse *b* may be removed entirely without disturbance of operation.

Analyzing the functions of the middle wire and fuse *b*, we find: If all lamps are burning and an equal wattage obtains on each side, fuse *b* is "idle," passing no current. Under same conditions and all fuses in place, if fuse *a* be removed, thus extinguishing the lights on A side, fuse *b* immediately comes into full play and in conjunction with fuse *c* comprises the cut-out for circuit B-C, or 11 lights. In the same manner fuse *c* may be removed and fuse *b* in conjunction with fuse *a* comprises the cut-out for the circuit A-B, of 11 lights. And, ordinarily, with balanced conditions, fuses *a* and *b* comprise the cut-out for circuit A-B, of 22 lights.

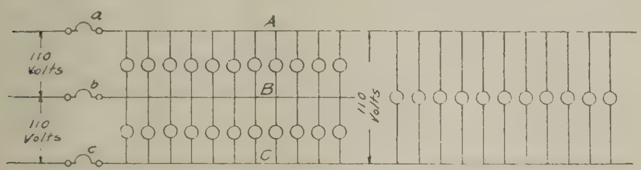


FIG. 3. A 3-WIRE, 3-PHASE SYSTEM.

Figure 3 illustrates the simplest form of a three-phase, 110 volt lighting circuit. This circuit is protected by a triple pole block with 3 fuses, *a, b, c*. In Figure 3, 11-60 watt lamps are shown between each pair of wires, making 33 in all. Apparently, at first sight, this is correct, for reasoning as outlined above 11 lamps "per side" are obtained.

If, as some seem to have interpreted the rule, 660 watts were allowed between any pair of wires at a potential difference of 110 volts and this was the limiting feature intended under Rule 23, it is clear that 11-60 watt lamps could be placed between A and B, between B and C, and between C and A, making a total of 33 lamps, or 1,980 watts on the cut-out, *a, b, c*. Now, for a balanced 3-phase, non-inductive circuit, the amperes as measured in one leg is the same for all three. Then $I \times E \times 1.732 = \text{Watts}$. $(1{,}980)/(110 \times 1.732) = 10.38$ amperes per fuse.

As a matter of fact, with a two-wire circuit supplying 660 watts, a 6 ampere fuse is too close to actual requirements for practical operation, and at least 10 ampere fuses are used. Thus it will be noted that if 660 watts be allowed between each pair of wires on a 3-phase, 3-wire branch circuit, 10 ampere fuses will be too small for actual requirements and 15 ampere fuses will be used in actual practice. Knowing that this increase in actual fuse capacity has been permitted, the argument by those above mentioned has been for 660 watts between any two wires at a difference of potential of 110 volts.

No criticism of the Code is intended, but it will be clear to those of us who are familiar with the matter of circuits just outlined, that the Rule is not sufficiently definite in this matter. "For," reason some of our friends, "if the rule does limit fuses to 6 amperes on branch circuits from 55 to 125 volts, it is clear that 660 watts exactly calls for 6 amperes, and this is too close for a 6 ampere fuse to give perfect satisfaction in operation." The limit of 660 watts on any one cut-out for branch circuits, and further mention of 6 amperes for branch circuits of approximately 110 volts is not thoroughly in accord, considering the actual necessities of practice. And as practically every one realizes that for 660 watt branch circuits the fuses are, in practice, increased beyond 6 amperes, it follows that 660 watts have been recognized as the limiting feature, and not the 6 ampere fuse. And thus the points in question arise.

However, we are reasonably sure that the Code intends that the branch circuits be limited to 660 watts per cut-out and that the 6 ampere fuse further intends to limit the actual working current to 6 amperes. This being true, a 3-phase, 3-wire branch circuit would not be in accord with the Code when supplying 660 watts per phase or 1,980 total. Limiting the working current over any fuse of the cut-out to 6 amperes, we have, $6 \times 110 \times 1.732 = 1{,}143.12$ watts. And assuming use of 60 watt lamps, we have $1143.12/60 = 19$ lamps, total. Or, 6 on phase A, 6 on phase B, and 7 on phase C.

Analyzing the operation of a 3-phase, 3-wire, 110 volt circuit as in Fig. 3, but with 6 lamps of 60 watts per side, we have, $(3 \times 6 \times 60)/(110 \times 1.732) = 5.66$ amperes per fuse. With all lamps burning, remove fuse *b*. We then have in principle, a two-wire circuit A-B with 6 lamps at 110 volts in full operation and 6 series of 2 lamps each. Assuming 60 watt Tungsten lamps, the 6 lamps directly on 110 volts will require 3.27 amperes. The group of series (burning dimly) will require 2.166 amperes. Then fuses *a* and *c* will pass $3.27 + 2.166 = 5.44$ amperes. This further bears out the idea that 6 amperes working current is the limiting feature and that for a 3-phase, 3-wire branch circuit the total lamps should be limited to 19.

If then, with a 2-wire branch circuit we can supply 11 60 watt lamps and with an Edison branch circuit we can supply 22—60 watt lamps; wherein lies the advantage of distribution by 3-wire, 3-phase branch circuits limited to 19 60-watt lamps? For given conditions of distribution, it is clear that if we consider the amount of copper required for a two wire system as 100%, that necessary for an Edison system with neutral equal in cross section to one of the outside wires, will be 37.5%. With a 3-wire, 3-phase system, the relative amount of copper will be 75%. Then, from a copper basis alone, the Edison system is preferable.

Basing on one small textile mill the author has in mind, requiring 42 K.W. in lights, or 8% of the total light and power load, the following is found to be true: Edison system, 3% of delivered power in lines and neutral equal to one of the outsides, 707.7 lbs. actual copper. Three-wire, 3-phase, 3% loss of power, 1063.5 lbs. actual copper. The labor for installation and the cut-outs and switches being practically the same in both systems, it will be noted that 355.8 lbs. less copper is required for the Edison system. The transformers of equal capacities, the cost of the three-phase will be in excess of that required by the Edison system. In this particular case the cost of transformers being about 1/3 more for 3-phase than for Edison system.

Except for the convenience of the three-phase system in maintaining a balance on the local generators in private plants having scattered buildings, it is apparent that the Edison system is preferable in ordinary textile plants. In plants having a larger percentage of lighting load than the case illustrated above, and operating 3-phase, the choice of the system is to be more carefully considered.

A. I. E. E. Code of Professional Conduct.

The following is the code of principles of professional conduct adopted by the board of directors of the American Institute of Electrical Engineers at its meeting on March 8th. While these principles express, generally, the engi-

neer's relations to client, employer, the public and the engineering fraternity, it is not presumed that they define all of the engineer's duties and obligations.

GENERAL PRINCIPLES.

1. In all of his relations the engineer should be guided by the highest principles of honor.

2. It is the duty of the engineer to satisfy himself to the best of his ability that the enterprises with which he becomes identified are of legitimate character. If after becoming associated with an enterprise he finds it to be of questionable character, he should sever his connection with it as soon as practicable.

THE ENGINEER'S RELATIONS TO CLIENT OR EMPLOYER.

3. The engineer should consider the protection of a client's or employer's interests his first professional obligation, and therefore should avoid every act contrary to this duty. If any other coniderations, such as professional obligations or restrictions, interfere with his meeting the legitimate expectation of a client or employer, the engineer should inform him of the situation.

4. An engineer can not honorably accept compensation, financial or otherwise, from more than one interested party, without the consent of all parties. The engineer, whether consulting, designing, installing or operating, must not accept commissions, directly or indirectly, from parties dealing with his client or employer.

5. An engineer called upon to decide on the use of inventions, apparatus, or anything in which he has a financial interest, should make his status in the matter clearly understood before engagement.

6. An engineer in independent practice may be employed by more than one party, when the interests of the several parties do not conflict, and it should be understood that he is not expected to devote his entire time to the work of one, but is free to carry out other engagements. A consulting engineer permanently retained by a party, should notify others of this affiliation before entering into relatons with them, if, in his opinion, the interests might conflict.

7. An engineer should consider it his duty to make every effort to remedy dangerous defects in apparatus or structures or dangerous conditions of operation, and should bring these to the attention of his client or employer.

OWNERSHIP OF ENGINEERING RECORDS AND DATA.

8. It is desirable that an engineer undertaking for others work in connection with which he may make improvements, inventions, plans, designs, or other records, should enter into an agreement regarding their ownership.

9. If an engineer uses information which is not common knowledge or public property, but which he obtains from a client or employer, the results in the form of plans, designs, or other records, should not be regarded as his property, but the property of his client or employer.

10. If an engineer uses only his own knowledge, or information which by prior publication, or otherwise, is public property and obtains no engineering data from a client or employer, except performance specifications or routine information; then in the absence of an agreement to the contrary the results in the form of inventions, plans, designs, or other records, should be regarded as the property of the engineer, and the client or employer should be entitled to their use only in the case for which the engineer was retained.

11. All work and results accomplished by the engineer in the form of inventions, plans, designs, or other records, that are outside of the field of engineering for which a client or employer has retained him, should be regarded as the engineer's property unless there is an agreement to the contrary.

12. When an engineer or manufacturer builds apparatus from designs supplied to him by a customer, the designs remain the property of the customer and should not be duplicated by the engineer or manufacturer for others without express permission. When the engineer or manufacturer and a customer jointly work out designs and plans or develop inventions, a clear understanding should be reached before the beginning of the work regarding the respective rights of ownership in any invention, designs, or matters of similar character, that may result.

13. Any engineering data or information which an engineer obtains from his client or employer, or which he creates as a result of such information, must be considered confidential by the engineer; and while he is justified in using such data or information in his own practice as forming part of his professional experience, its publication without express permission is improper.

14. Designs, data, records, and notes made by an employee and referring exclusively to his employer's work, should be regarded as his employer's property.

15. A customer, in buying apparatus, does not acquire any right in its design, but only the use of the apparatus purchased. A client does not acquire any right to the plans made by a consulting engineer except for the specific case for which they were made.

THE ENGINEER'S RELATIONS TO THE PUBLIC.

16. The engineer should endeavor to assist the public to a fair and correct general understanding of engineering matters, to extend the general knowledge of engineering, and to discourage the appearance of untrue, unfair or exaggerated statements on engineering subjects in the press or elsewhere, especially if these statements may lead to, or are made for the purpose of, inducing the public to participate in unworthy enterprises.

17. Technical discussions and criticisms of engineering subjects should not be conducted in the public press, but before engineering societies, or in the technical press.

18. It is desirable that first publication concerning inventions or other engineering advances should not be made through the public press, but before engineering societies or through technical publications.

19. It is unprofessional to give an opinion on a subject without being fully informed as to all the facts relating thereto and as to the purposes for which the information is asked. The opinion should contain a full statement of the conditions under which it applies.

ENGINEER'S RELATIONS TO ENGINEERING FRATERNITY.

20. The engineer should take an interest in and assist his fellow engineers by exchange of general information and experience, by instruction and similar aid, through the engineering societies or by other means. He should endeavor to protect all reputable engineers from misrepresentation.

21. The engineer should take care that credit for engineering work is attributed to those who, so far as his knowledge of the matter goes, are the real authors of such work.

22. An engineer in responsible charge of work should not permit non-technical persons to overrule his engineering judgments on purely engineering grounds.

National Electrical Code Revision.

At the meeting of the electrical committee of the National Fire Protection Association, held at Boston, March 27th, a number of revisions were carefully considered, some being adopted and others referred to committees for still further consideration. The proposed revision on the matter of grounding low potential circuits was especially discussed, in view of the fact that a special committee representing the American Institute of Electrical Engineers, the Association of Edison Illuminating Companies, The National Electrical Inspectors' Association, and the National Electric Light Association, reported to the convention that at a conference held in New York on March 12th, this special committee decided unanimously to recommend to the electrical committee of the National Fire Protection Association that Rules 15a and 15 b be modified and amended. The revised wording as recommended by the special committee is given below, the words indicated in brackets being the words to be omitted and the words in italics to be the new words in the revision.

Rule 15a. Neutral wire (may) *must* be grounded and (when grounded) the following rules must be complied with:

Rule 15a. Omit the following fine print notes: (Inspection Departments having jurisdiction may require grounding if they deem it necessary.) (Two-wire direct current systems having no accessible neutral point are not to be grounded.)

Rule 15b. Transformer secondaries of distributing systems (should preferably) *must* be grounded, *provided the maximum difference of potential between the grounded point and any other point in the circuit does not exceed* (250) *150 volts and* the following rules must be complied with:

Rule 15b-2. When no neutral point or wire is accessible one side of the secondary circuit (may) *must* be grounded, (provided the maximum difference of potential between the grounded point and any other point in the circuit does not exceed 250 volts.)

Rule 15b. Omit the following fine print note: (Inspection Departments having jurisdiction may require grounding if they deem it necessary.)

A new paragraph to be inserted to be known as 15b-4 to read as follows: Where the maximum difference of potential between the grounded point and any other point in the circuit exceeds 150 volts, grounding may be permitted.

A fine print paragraph to be added after 15g to read as follows: Companies and departments in charge of waterworks are urged to allow the attaching of ground wires to their piping systems in the full confidence that the integrity of such piping systems will in no way be affected, whatever may be the normal voltage.

The result of the consideration of the Electrical Committee at the Boston convention was that it decided that these changes should be made. It also adopted and suggested minor changes to other sections. The committee decided not to make the foregoing changes in Rule 15 mandatory now, but will allow their adoption in any locality where it is desired, no inforcement being attempted until the next convention of the National Fire Protection Association has indorsed the changes. The matter of recommendations to county and municipal authorities governing transmission line construction as presented by A. M. Schoen, chief engineer of the Southeastern Underwriters' Association at the March meeting of the Atlanta section of the A. I. E. E and reported in our April issue, was taken up and a committee appointed to reconsider Rule 13 recommending the necessary changes and additions.

Thirty-Fourth Convention of the N. E. L. A. to Be Held at Seattle, Washington.

Plans are now definitely formulated for the 35th annual convention of the National Electric Light Association to be held at Seattle, Wash., June 10th to 15th, inclusive. The convention headquarters will be located in the state armory, the building offering attractive facilities for purposes of the association. As usual there will be ample provision for exhibits and the drill hall of the armory, a space approximately 200 feet by 100, will be used for this purpose. The exhibit hall has been layed out in such a way as to provide exhibiting booths of good proportion with special decorative treatment after the general plan of arrangements for past exhibits.

In view of the fact that a trans-continental trip is offered members in the Southern and Eastern sections, special tours have been made up covering various sections of the country and taking in many famous points of interest. This is the first time that the National Electric Light Association has held its annual convention on the Pacific coast, and special arrangements have been made so that those participating in the different tours will be afforded every opportunity to view the principal scenic wonders of the West. In general the cost of these tours is based on the old expense plan, this including the railway and sleeping car fares, meals, and side trips at all points, except at Seattle during the convention.

Four tours have been planned, known as Tours A, B, C, and D, of which tour D described below, is of special interest to Southern members. Tour A or the Tour De Luxe, has arrangements for two trains, one starting from the Grand Central Station at New York City, and one starting from the North Station at Boston, Mass. The former will be known as the Red Special, and the latter as the Blue Special. Each will stop at the following points on the going trip: Grand Canyon of Arizona, Riverside, Pasadena, Los Angeles, Santa Barbara, Bel Monte, San Francisco, and Shasta Route to Seattle. On the return trip stops will be made at Portland, Yellowstone National Park, Salt Lake City, Glenwood Springs, Colorado Rockies, Colorado Springs, and Denver. Both trains leave on May 26th, the one from New York City, at 4:05 p. m., the one from Boston at 1 p. m. The former arrives at Seattle Sunday, June 9th, at 2 p. m., and returns so as to reach New York City Saturday, June 29th. The Blue Special or the train leaving from Boston, arrives in Seattle on June 9th also at 2 p. m., and returns so as to arrive at Boston Saturday, June 29th, about noon.

Tour B has arrangements for two trains, one leaving the Pennsylvania Terminal Station at New York City, and the other leaving the Grand Central Station, Fiftieth Ave. and Harris St., Chicago. Both trains stop at the same points, the New York train leaving June 3rd at 8:50 a.m., and arriving at Seattle, Sunday, June 9th, at 9:30 p. m. The Chicago train leaves Chicago on June 4th at 8 a. m., and arriving at Seattle Sunday, June 9th, at 9:30 p. m. The points visted on this tour will include Banff Hot Springs, Lake Louise, through the Canadian Rockies to the Glaciers, and Fraser Canyon to Vancouver, then by steamer to Victoria and Seattle.

Tour C has arrangements for one train only, leaving the Union Passenger station at Canal and Adams Streets, Chicago. This tour is a going trip only and is not on the all expense plan. The trip will be by way of Chicago, Milwaukee, and St. Paul Railroad, and the Chicago, Milwaukee and Puget Sound Railroad. The train leaves Chicago, June 6th, at 4:30 p. m., arriving at Seattle June 9th, at 2:30 p. m. This train is known as the Business Man's Train from Chicago and will have as one of the cars a special car carrying a number of officers of the Association and members of the H. M. Byllesby & Co. organization. This latter organization has sent invitations to friends to select this train.

Tour D has provision for one train starting from the Union Station at St. Louis, on Wednesday, June 5th, at 9:04 a. m., and arriving at Seattle, Sunday, June 9th, at 8:15 p. m. The arrangements on this train are not on the all expense plan, and the trip is a going one only, by way of Wabash Railroad to Kansas City, Chicago, Burlington, and Quincy Railroad to Billings, and the Great Northern. The tour D is probably the one which most Southern members will find interesting, in view of the fact that it is known as a trip planned in the interest of the members of the National Association, located in the cities of the South and Southwest. A round trip railroad fare on this train starting from Atlanta will cost $88.10, from Birmingham, Ala., 82.70, from New Orleans, $77.50, from Memphis, Tenn., $74.75, from Chattanooga, Tenn., $82.60. About $30.00 additional should be added to this for Pullman service going and returning. If passengers desire to travel by way of California, through San Francisco, Sacramento, Los Angeles, and other cities, an additional charge of $15.00 is made. The selling dates for tickets is May 27th and 28th, June 3d, 4th, 5th and 6th, and these tickets are good to reach original starting points up to and including July 27th, 1912. Special hotel arrangements have been made and members are requested to apply for reservations as early as possible. Information in regard to hotel accommodations can be secured from W. J. Grambs, of Seattle, Washington.

With regard to the arrangement of the program, President Gilchrist announces that it is intended to dispose of the business in about eight sessions, some of which would be in parallel, this being needed to take care of the sixty-six items in the shape of papers, reports and special addresses. It was arranged during the conference that the Commercial Section would divide up its work this year into four sessions, as it did last year. There will probably be three meetings on Tuesday; three on Wednesday, and two on Thursday, and this will allow the Exhibit to be thrown open to the general public on Thursday evening, an arrangement which will enable the Association to comply with the general wish of the citizens to see this fine display of electrical apparatus—it being the first of the kind in Seattle.

April Meeting of Atlanta Section of A. I. E. E.

The April meeting of the Atlanta Section of the A. I. E. E. was held April 17, at the University Club, Mr. A. M. Schoen, the Section Chairman, presiding. The topic of the evening was, The Synchronous Condenser for Improvement of Power Factors. A paper was delivered on this subject by H. E. Bussey, Resident Engineer for the General Electric Co. Mr. Bussey's talk while comprehensive as far as the theoretical operation of the synchronous condenser is concerned, was replete with data and information drawn from his personal experience representing a variety of conditions on a variety of systems. On account of this latter feature of the treatment of the subject by him many points of interest were brought up for comment during the discussion of the paper. We present herewith an abstract of Mr. Bussey's remarks, together with the main points touched upon during the discussion:

In his opening remarks Mr. Bussey outlined the elementary characteristics of alternating current circuits and carefully explained the relations in circuits where the current and voltage differ in phase or angular position. He stated that no power is required to place the ether in a condition of stress, in other words magnetize it, the current producing the condition lagging behind the voltage by 90 degrees. The commercial magnetic materials such as iron or steel, however, have a tendency to retain magnetic lines and also to resist the growth of lines upon application of an emf. This property occasions an energy expenditure which is hysteresis, showing itself in the form of heat. The power component of this magnetizing current is relatively small as compared with the actual magnetizing current, so that the power factor of any A. C. apparatus running under no load is very low.

In referring to the industrial use of motors Mr. Bussey said that the synchronous motor has been seldom used, due to the fact that it requires a direct current source of excitation and somewhat more intelligence to operate than the induction motor. Induction motors take their magnetizing current from the line and for this reason they are fractional power factor machines. The synchronous motor has an external source of excitation, variable at will and not only supplies its own magneto-motive force but will also supply the magnetizing current to inductive apparatus on the same lines.

Stress was laid upon the fact that a reduced capacity of generators, transformer lines, etc., results when a low power factor is permitted. A. C. generators and transformers are rated on a basis of unity power factor or in Kva. That is a 100 Kw. machine will deliver 100 Kw. at unity power factor, but will deliver only 80 Kw. at 0.8 power factor. Unless machines are designed for low power factors, it is doubtful if the voltage of the system can be kept up. The effect of low power factor on distribution lines Mr. Bussey showed by the following case. Assume a distance of five miles and a load of 1,000 Kw. required to deliver this load at about 6,000 volts and a ten per cent. energy loss. Each conductor of a three-phase line at unity power factor would be 79,200 c.m. At 90 per cent. power factor 97,533 c.m., and at 60 per cent. 218,000 c.m., or at the power factor 60 per cent. the investment in copper would be 2.8 times as much. If the same size wire were used at both unity and .6 lagging power factor the loss would be about 28 per cent. Transformers are reduced in capacity in a similar ratio to the reduction in capacity of generators when operated under low power factors. The regulation is not as materially affected. A transformer having a regulation of 1 per cent. at 1.0 P.F. will have a regulation of about 3 per cent. at 0.7 P.F.

A very important effect of low power factors on generating stations is the influence on load factors on prime movers. A great many stations have been laid out on a basis of unity power factor and with the generators operat-

ing at full Kva. output and reduced energy output, the economies of the prime movers are seriously affected. Also there is a large proportion of the capacity of prime movers doing no work due to the fact that the output of the generators are limited and materially decreased by low power factor.

The synchronous condenser floating on the line offers an excellent way out of this difficulty and at a relatively low cost a large portion of the capacity of the prime movers may be reclaimed by raising the power factor. Assuming that the power factor on the station bus is .71, the following will show the relative improvement in power factors and increase of generator capacity rendered available by the higher power factor:

Kva. Additions in per cent. of the Amount Necessary to Raise P.F. to 1.	Resulting P.F.	Per Cent. of Generator Capacity Rendered Available.
0	71	0
10	77.1	6.1
20	82.5	11.5
30	86.8	15.8
40	90.5	19.5
50	93.5	22.5
60	95.8	24.8
70	97.8	26.8
80	99.0	28.
90	99.7	28.7
100	100.	29.

From the table it can be seen that it is hardly economy to raise the power factor higher than 90 to 95 per cent., due to the large synchronous condenser capacity to raise the P.F. beyond this amount and the relatively small benefits accruing. It should be borne in mind that a condenser installed on the bus bars does not benefit anything except the generators. In order to secure benefits for lines the condenser must be installed at the ends of such lines.

Mr. Bussey referred to typical synchronous condenser installations, including the Cleveland Electric Illuminating Co., one of the first stations to try out the equipment. Here more than 40 per cent. of the connected load is induction motors, but with synchronous motors properly located at sub-stations and on customer's premises the power factor is maintained at a high value. The 200 Kva. synchronous motor has been chosen as standard and installed in customer's plants where more than 400 hp. in motors is used.

At the plant of the Illinois Steel Co., of South Chicago, synchronous condensers are installed on the feeder system serving a single plant of large capacity. At Buffington, 10 miles from generating station where a 24-hour load of induction motors is carried in a cement mill, two synchronous condensers are installed, each rated at 1650 Kva. With condensers out of service, 6,100 Kw. at .74 power factor, on 2,200 volt bus at South Chicago, at Buffington, 580 Kw., 450 volts on low tension bus. With condensers in operation and taking exactly full load amperes from low tension bus at Buffington, the results are, 6,400 Kw. at .917 power factor on 2,200 volt bus at South Chicago, 6,150 Kw., 475 volts on low tension bus at Buffington. With 25 per cent. overload on condensers, the readings are 6,400 Kw. at .934 power factor at South Chicago, at Buffington, 6,050 Kw., 485 volts. These are cases of which many others might be cited.

DISCUSSION OF MR. BUSSEY'S PAPER.

The discussion following Mr. Bussey's remarks was taken up by A. M. Schoen, Chief Engineer Southeastern Underwriters' Association, E. P. Peck, Assistant Electrical Engineer of the Georgia Railway and Power Co., H. P. Wood, Professor Electrical Engineering, Georgia School of Technology, and T. G. Seidell, Electrical Engineer, of Atlanta. Mr. Peck showed voltage charts of his system before and after installing a 1500 Kva. condenser. The improvement in voltage was decidedly noticeable while the power factor was raised from a very low value to about 90%. This figure was named as about the limit of economical correction of power factor, since above this point, for a very small raise in power factor a comparatively large amount of leading wattless component is required. The features of design made necessary and the increased cost per Kva., for a machine to carry both mechanical load and exert a corrective effect, were touched upon. The average cost of the synchronous motor for carrying a mechanical load and furnishing leading wattless current was placed at about $10 per Kva. with the cost of the synchronous condenser designed for corrective effect only at about $6 per Kva. The airgap requirements and motor requirements as to field design were given as the causes for the increased cost of synchronous motor.

Convention of Mississippi Electric Association.

As announced in last issue, the fourth annual convention of the Mississippi Electric Association, a State Section of the N. E. L. A., will be held at Vicksburg, Miss., May 28, 29 and 30. Judging from the success of the convention last year and the indications for the coming meeting, the attendance will be considerably increased over that of last year. In view of this fact, the secretary, Mr. A. H. Jones, of McComb, Miss., makes a special request that all those expecting to attend notify him as early as possible so as to facilitate the work of registration.

The program to be followed is given herewith: Tuesday, A. M., May 28. Address of Welcome, by Hon. J. J. Hayes, Mayor of Vicksburg. Response by Jack Abbott, President of the Association. President's Address. Paper by R. C. Lamphier on Review of the Development and Present Types of Induction Meters. Tuesday, P. M., Executive session for Class A and B members. Paper, Grounding of Secondaries, by J. T. Robertson. Report of Secretary and Treasurer.

Wednesday, A. M., May 29. Paper, Transformers and Induction Regulators, by C. E. Allen. Paper, Modern Car Construction for Small Cities. Paper, Rates for Electric Service, by G. S. Merrill. Wednesday, P. M., Executive Session.

Thursday, A. M., May 30. Paper, Mixed Pressure Turbines up to 750 KW., by H. E. Bussey. Paper, Coal, Hand and Mechanically Fired, by W. F. Gorenflo. Thursday, P. M., Executive Session. Report of committees and election of officers.

The entertainment features have been especially taken care of, and include an informal reception Tuesday evening, a sight-seeing trip through Vicksburg Wednesday afternoon, and a banquet Thursday evening. A rejuvenation of the Sons of Jove will be held also Wednesday evening.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

A NEW DEPARTMENT.

In the April issue of SOUTHERN ELECTRICIAN, we inaugurated a new department to be known by the above title, "New Business Methods and Results." It will be our object to discuss in this department matters connected with the commercial side of the central station business and that of the electrical dealer and contractor, giving the widest possible range to the topics. We intend each month to take up some particular phase of the new business problem, outlining the subject editorially, and asking for comment or discussion from all interested. We will also gladly receive suggestions for future topics, or the details of how you have solved some commercial problem. If you have any unsolved problems, campaigns about to start or under way, and would like to have the experience of others or certain questions answered, state your case, or send in your question, and we will present the same through these columns. A list of topics to be treated and the order in which they come will be published in an early issue. We solicit your suggestions for same.

It is our purpose to make this section of value to every central station jobber, electrical dealer and contractor, and we can only do so through your co-operation. We trust that no one will feel so big as to be above giving us the details of his campaign or other proposition nor so small as to feel that his comments are not of value.—Address correspondence to Editor New Business Section.

A Resume of Last Month's Discussion.

The hearty response given the request of the Editors of Southern Electrician for discussions on the trade relationship between the central station, the contractor and the manufacturer has been gratifying from our standpoint and we hope interesting, as well as instructive, from the standpoint of readers. The first thing to claim the attention of one reading these comments is the fact that the writers have apparently had this matter on their minds for some time and have welcomed a chance to express themselves in regard to it. Furthermore there was no uncertain note in regard to the opinions given, but each one seemed to have well settled convictions regarding the points for which he was contending. As is natural, each class of contributors looked at the situation from their standpoint, although some of the writers, we were pleased to note, felt that the success of the electrical industry is really a bigger thing to work for than personal advantage. Central station men practically all favored co-operation, but for the most part seemed to feel that the sale of appliances should not be left entirely to the contractor or electrical supply dealer. The contractors, on the other hand, as earnestly contended that they were the only logical distributors, although their principal objection seemed to be against the practice of the central stations to cut the price. The manufacturers also protested vigorously against this pernicious (and this term is scarcely strong enough) practice. Indeed we were most pleased to note that none of the central station contributors expressed themselves in favor of price cutting.

In view of these general expressions, we feel justified in the frank statement that the next step in co-operation must come from the electrical contractor. Most of the central station, feeling that it would not recommend any have crowded the contractors out of the wiring business either have or are giving it up. Many that have cut the prices on appliances are coming to see that it is not good policy. If it now develops that it is for the best interests of the electrical industry that the central station should handle certain appliances, encouraging the sale of them through the contractor as well, it is surely a short sighted policy on the part of the latter to refuse co-operation until he gets all the concessions he thinks he should have. Among all the articles presented, we believe the one by Mr. Gresham, on page 160, sets forth fully and logically the factors in the case.

Two or three other statements call for passing comment. One writer gave as a reason for turning the sale of devices entirely over to the contractor, that the customer would naturally be skeptical of statements made by the central station, feeling that they would not recommend any article unless it consumed considerable current. Such a state of affairs would indicate little or no confidence between the corporation and the public, and we cannot believe that such a state of affairs exists under proper present day management. Of course there are exceptions. We once knew of a druggist, who positively refused for years to have anything to do with the tungsten lamp, because it was suggested to him by a solicitor of the lighting company, for he could not understand why the company should recommend anything that would reduce his bills. These cases are not typical of public relationship.

Another writer has said that the contractor should go out with his catalog and talk up appliances. We see no reason why he could not, and rather believe that for the good of all he should. But when we consider the universal fact that he doesn't, even where he has an even chance at new business, we are led to think that perhaps there is a logical reason for this, and that perhaps after all he should not, in all cases, be expected to. A brief study of the average contractor's business shows that his organization is not suited to such work. His men who travel around in search of business are not primarily solicitors, but estimators, looking up new buildings and figuring on the wiring. The employment of special appliance solicitors is, as a rule, therefore necessary, and this would seldom pay.

One other writer referred to Contractors' Associations, and intimated that the same might be organized and to a measure controlled by the local central station. On this we say, *don't*. Co-operation does not mean interference. The contractors have their own problems, which they must work out themselves, and they will feel freer in doing so if allowed to do it in their own way. Let the central station encourage the movement, and extend compliments, or greetings, but let it go at that.

Eugene Creed, Sales Manager of the Morris Iron Co., Frederick, Md., on the Discussion in the April Issue on Trade Relationship.

I note with much interest that in the April issue of Southern Electrician you have inaugurated a new department known as the "New Business Methods and Results Department," and I have read carefully the views of the different writers on trade relationship between the manu-

facturers of current consuming devices, electrical dealers, contractors and central station men. The writer was for over ten years in the commercial departments of different electric light companies, all of whom sold heating appliances, motors, etc., at a profit, pursuing a policy which would not conflict with the local dealers and contractors. As sales manager of an electric light company operating in a town of 375,000 people, we were able to sell in two years, 6,000 electric flat irons alone at a price to the consumer which netted us a profit of 20 per cent. on each iron. It is true that the appliances were sold on the installment plan, but they were sold at a profit and that is the point I wish to impress upon central station managers and new business men. Co-operation should be the watchword of every central station manager who operates in the South or any other part of the country for that matter. Co-operation means co-operation; nothing more nor less. I have interviewed central station managers who boasted that their prices were lower, and that they sold more appliances than the electrical contractor just a few doors below, a man who could not make a profit from the electricity which the appliances would consume for the rest of its working life. If a sales manager or new business man cannot sell the appliances at a fair profit he had better get out of the business. It is just as easy to sell a flat iron for $5.00 as it is to sell it for $3.50. Same rule applies to other appliances.

There is no question but that the agitation for municipal ownership which has no slight effect upon the value of stocks of different electric light companies, has been inspired by the policy of grabbing everything in sight. As some great statesmen in the early part of the Nation's life said, "We must hang together or hang separately." To cut the discussion down to a few words, no central station manager is justified in using a cut-throat, or cut price practice, unless competing with a generating company.

Mr. F. Bissell, President of the F. Bissell Co., on Points of the Discussion in April Issue.

The writer has gone over the discussion in your April issue, and some of your points are very interesting. We agree heartily that the central stations should take every opportunity to educate the public in general, that they should discourage extreme cutting of prices and that they should not permit prices becoming prohibitively high. We disagree entirely in the lamp arguments, for the central stations are no more required to distribute lamps than heaters. It has been claimed by some very good authority that in five or ten years the heating load will exceed the lighting load. We think more was done to discourage proper retailing when the central stations accepted the bait of the lamp manufacturers and adopted the free renewal plan, for that was at the time, the big item and is yet, and it is very hard indeed for the dealers to recover from that "stunner."

I think with a growing familiarity with merchandise as distinguished from engineering, that lighting companies will come more and more to the realization that the way to sell quantities of current and to make money out of it, is to stick to the current, and if necessary reduce the price, which after all is the best, quickest and most prominent way to "popularize electricity." A saving is brought about by not trying to run a selling department which can be better taken care of by those entirely outside and separate from the lighting companies. Those who do maintain such departments should adopt the excellent example which Mr. Rakestraw shows on page 158.

Mr. Hickox's suggestion on page 159, that sales people be permitted to meet traveling men, is another excellent idea, for obviously the salesman should be and generally is an expert, and much can be gained from him which will put the sales people in a position to sell more merchandise.

Mr. Turner's suggestion on page 166, that the central stations would complain if isolated plants adopted the same tactics which the central stations are now using, is worthy of much consideration.

On page 169 Mr. De Marco's comment on the reduction in the price of current itself is right in line with the everlasting rules of business, and is reduction put where it will really do the most good.

Turning back to page 158 we note the loss of $472.09 on the department costing only $53.00 per month, which of course is a very small department. Yet had that net loss of say $40.00 per month been applied on the current it would have been 1 cent on 4000 K.W., 2 cents on 2000 K.W., or 4 cents on 1000 K. W., per month. Obviously this is a very small total, but it was a very small department, and in the way of example goes to show how difficult it is to shore up a business from the outside when what it really needs is more concrete in the foundation. All of this is respectfully submitted, the subject is very important, and we trust you will continue your good work.

Recent Practice in the Development of a Residence Load.

Many operating companies have in the past made no special effort to increase the residence load, allowing it to grow naturally with the population. This attitude has come about largely from the idea that the added load scarcely paid, in fact, was more bother than it was worth. Consequently the energies of the management have been devoted towards securing power contracts, commercial lighting and other business which was considered worth while. Today, the fact that residence business does pay, has been pretty well proven. While small individually, the aggregate is large, and while to a large extent an evening load, the load factor is better than that of most commercial lighting. Furthermore, the introduction of household appliances has increased considerably the revenue from this class of business at little additional expense.

The extension of residence business depends very largely upon wiring conditions. In most towns the electric light companies have practically all of the desirable properties that are wired, while even with natural gas competition, 75 or 80 per cent. can be secured. We quote Pittsburg as an example. The obstacle in most places lies in the great number of unwired houses, it being not uncommon to find cities containing from 16,000 to 20,000 dwellings with only from 500 to 2,000 wired. Hence the principal feature of residence campaigns in such places must necessarily be mainly along the lines of a wiring campaign.

But why, it may be asked, need there be a campaign at all? Why not patiently, quietly, but persistently convince by sane reasoning, the advantages of electric service? In time this is sure to produce results, it however lacks one valuable element present in campaign work, namely, enthusiasm. Much as a safe, sane, conservative proposition is to all desirable and admirable, and as much as we are personally inclined to appeals to the cool judgment, yet it

is true that it takes an enthusiastic campaign to move numbers of people to action, and though it may be full of glaring errors, it will produce results that months and years of more conservative effort would not accomplish. As a commercial man from Kansas City states it, the sheer momentum of the campaign greatly aids in getting results quickly. However this may be, the explanation seems to lie in the fact that human nature is in most cases moved by impulse rather than by reason and that the concerted effort of a body of men who are thoroughly impressed with the value of their proposition, and who are in the heat of a business contest, reacts upon the prospective customer in such a way as to greatly aid in securing an immediate decision.

Let this not be accepted as an approval of any "slipshod," "half-baked" campaign methods. There must be a conservative element, every step carefully planned, and every contingency guarded against. The work of others should be studied, and improved upon where possible, and every precaution taken to secure substantial, permanent results.

What then are the elements of a successful campaign? They are,

(1) To formulate an attractive proposition.

(2) To get it before the public as widely and quickly as possible.

(3) To take care of the interest developed and conserve the results.

First, the proposition to be attractive must be inexpensive, that is, it must be popular in price, it must attract by its price alone. It should make the man you are after say, "Well, that's what I've been looking for." Second, it must be flexible. If the class of persons you are trying to get are salaried employees, many of whom are paying for their homes, and deferred payments are needed, your proposition must fit their case. If you have a number of prospects who can afford to pay cash, offer an attractive cash discount, etc. Third, it should be easily understood. The cost of wiring should be reduced to its simplest terms, such as a flat rate per outlet, with a simple schedule of additions and exceptions, so that the solicitor will have no trouble figuring it out on the premises.

There are just two standard ways of getting an offer of this nature before the public. These are, newspaper advertising and direct solicitation. Others are of doubtful value, and should be used sparingly, if at all. Sometimes, something special in the advertising line has made good, while others that "listened good" have fallen completely flat. People can only be reached satisfactorily through the newspaper, and by way of the door bell. Advertising should be first, ample and second specific. Homeopathic doses are of no use in this case. Half or at least quarter pages should be used and for a couple of weeks in every paper in town, with daily changes. Then if desired, slack up and put forth another spurt at some seasonable time. The best results seem to be secured in early spring and early fall. The copy of all advertisements must be definite and explicit. Coupons to be sent in for further information or to have a solicitor call, are worthless. The advertisement should be so clear that the average householder can tell about what his particular house would cost to wire without further help, leaving as few explanations as possible for the solicitor to make. This procedure increasing the probability of the solicitor being able to do business on the first call, thus saving expense and enabling one man to cover more ground.

Solicitation is the most important feature of a campaign. A high class of men should be employed, intelligent, neat, and courteous. They should be assigned to a territory and not changed if it can be avoided. As to number, there should usually be at least one man for each 10,000 of the population. The idea is, of course, to see as many people as possible without skimming or slighting the work. On a new proposition enough time must be taken to go over the matter quite carefully with each prospect, and an effort made to close the business on the first call, or at least on the second. Evenings can be profitably utilized for special appointments with men who cannot be seen during the day time.

Every new customer should be a splendid neucleus for orders from others in the neighborhood. If a new customer is pleased he will naturally advertise the fact, if he is not he will do the same. It is therefore essential that the solicitor should call on every customer connected, within a few days and find out if he is pleased, and if not, to adjust the complaint at once and nip the incipient grievance in the bud. Unadjusted complaints among new customers will do more to hurt a campaign than any amount of grumbling from any one "chronic kicker." Unfavorable comment must be avoided at any cost, for a campaign to succeed.

The very nature of a special campaign forsees a close, a return to normal conditions. Care should be taken to conserve the fruits of the first efforts. If the force has been increased for the occasion, and in most cases this is necessary, an accurate return of all calls should be made, with the results of each. There is sure to be a number of persons, from whom, for good reasons, business could not be secured, who will sign orders for connections later. When a territory is redistributed among regular men, each one should have accurate information about such cases and see them at the proper time.

The matter of rates may have its effect in promoting a canvass. If a change in rate, such as a small reduction, can be authorized, it has a good effect. Many companies are getting splendid results from the use of the flat rate in connection with house wiring campaigns. Others have introduced a two-rate system.

As to whether the wiring should be done by the company's wiring department or turned over to local contractors, there is not much argument. By all means give it to the contractors. This should be done even where the company has wiremen and makes a practice of wiring. The co-operation of the contractors is too valuable to be sacrificed for the sake of the small profit which the wiring would bring in. On the other hand, it will be found to be a first-class plan to offer liberal commissions to contractors for obtaining unwired buildings, to be wired and connected to the service.

We present in this department, this issue, the details of a house wiring campaign at Mobile, Alabama; the results are interesting and are possible in other localities. Study them and our suggestions and try out a campaign.

A. G. Rakestraw.

The location of fixture outlets is dependent on the required distribution of the light to attain desired ends, and upon the effect of the light upon its surroundings.

The Results a Live House Wiring Campaign Can Accomplish.

[At Mobile, Ala., interesting new business developments have been worked up during the past year which have proven most successful to the central station management and to all others affected. An automobile electric battery inspection service has been installed which has worked out entirely satisfactory and already caused the sale of four electric automobiles and retained five in service. The company has added materially to its power load and was quite successful in a fall house wiring campaign during October. This campaign depended entirely upon newspaper advertising to obtain results and something like 80 house wiring contracts were secured in this way, without placing a single solicitor in the field. This campaign and the one of 1910 introduced electric service into more than 740 additional residences. Both campaigns were engineered and managed by Mr. R. E. Flower, New Business Manager of the Mobile Electric Company, and we present herewith the details of these campaigns as prepared by him. The results speak for themselves and may give a suggestion to others similarly located. If there are others who have secured results that compare with these, we would like to hear from them and publish details in the next issue.—EDITOR.]

When the Editor of this publication asked me to tell him something of our house wiring campaigns and what we had done to secure electric vehicle business, I was reminded that the new business department of the Mobile Electric Company is something like the darkey, who was being questioned by the Judge, before whom he was being tried for chicken stealing. The Judge said to him, "Boy, did you steal Mr. Blank's chickens?" "No, sah, Boss. I never stole no chickens." "What! you don't mean to tell me you never stole a chicken?" "No, sah, Your Honah, I neber was much on chickens, but I is sure powerful strong on ducks." We have not succeeded in selling many electric trucks, but we are sure "powerful strong" on house wiring campaigns.

During October, 1911, we secured 80 new residence customers, without the aid of a single solicitor. The credit, however, is due really to Mr. W. H. Hodge, publicity manager, of H. M. Byllesby & Company of Chicago, who prepared all of the copy which appeared in the local paers. The proposition was strictly an advertising one and the solicitors really did not work on it at all. Copies of the advertisements as they ran in the newspapers are shown here and will explain the proposition in detail.

This campaign resulted in a total of 89 coupons being deposited. Of this number 68 contracted for and had their houses wired during the month of October. Between November 1st, and January 1st, when the redemption period expired, 15 more contracts were completed, making a total of 83 houses wired. Out of this number all but three were connected to our lines immediately upon completion of the work. In other words, 93% of the self recorded prospects wired their houses and 96% of that number were immediately put into service.

This Proposition Will Interest Every Family Whose Home is Not Wired for Electric Light

The Electric Light Company will make you a present of the cost of soliciting housewiring business if you will take the trouble to come to our office

Good household lighting can be afforded by every family of moderate means. We have the figures to prove it.

The average bill for household lighting with electricity in this city is $1.82 per month.

For an average price of $1.82 per month is sold absolutely the best, the cleanest, the most convenient and the safest lighting in the world.

Lack of housewiring and fixtures is the only obstacle to perfect illumination in every comfortable home.

It is the first cost of electric lighting which deprives many families of one of the greatest conveniences of mankind.

We have studied the problem for years, with the object of overcoming this obstacle—of making it easier for people to wire their homes. We now have a plan which should demolish the last barrier of expense.

Our plan simply means giving the customer the usual cost of obtaining the business—the time and expense of expert salesmen.

All the customer has to do is to come to our office instead of letting us send a man to him.

You merely tear out the attached coupon and bring it to our office—then go to any electrical contractor and make your arrangements with him direct.

Later—when the job is complete—you present the contractor's receipted bill and we pay you 20 per cent of the amount in cash.

October is a dull month for electrical contractors. They are willing to make prices lower than ordinary.

There are no "strings" or conditions to this offer other than mentioned in this advertisement. It is bona fide and genuine in every way and means exactly what it says.

House Wiring Coupon.

Not Good Unless Presented in October and Redeemed Before January 1st, 1913.

This coupon presented at our office will be exchanged for a receipt entitling the holder to a cash discount of 20 per cent on house wiring jobs.

Houses must be adjacent to our lines, and completed and occupied. No discount in excess of $10 per house will be allowed. ITEM

MOBILE ELECTRIC COMPANY

THEO. K. JACKSON, General Manager. Telephones: Bell 3185 Home 22. 11 N Royal St.

OCTOBER 31st ABSOLUTELY ENDS OUR 20 PER CENT SAVING HOUSE WIRING PLAN

Only eight days are left to send or bring the attached certificate to our office and thereby save one-fifth of the cost of wiring your house for electric light.

Electric house wiring is not an expense. It is one of the soundest investments you can make. Any time you sell your property you can get the money back with interest.

Once the house is wired for electric light the job is done for all time. It will outlast the building.

Any dwelling is made more attractive by the installation of electric equipment.

Good household lighting can be afforded by every family of moderate means. We have the figures to prove it.

The average bill for residence lighting with electricity in this city is $1.82 per month.

For an average price of $1.82 per month is sold absolutely the best, the cleanest, the most convenient and the safest lighting in the world.

It would be cheap at twice the price.

Eyesight is precious. Good lighting is real economy.

One week is left to take advantage of this remarkable money-saving offer. Soon the electrical contractors will be busy installing signs, commercial lighting and power apparatus, and they cannot afford to take house-wiring jobs at low prices.

The number who have already accepted the offer is surprising. It is a tribute to the purchasing ability and thrift of our citizens.

Our proposition simply means paying the house owner instead of the salesman an amount equal to the ordinary cost of getting this class of business.

All the house owner has to do is to come or send to our office instead of letting us send a man to him.

First, present the attached coupon at our office, then go to any electrical contractor and make arrangements direct.

Later, when the job is complete, upon presentation of the contractors' receipted bill, we pay the coupon holder 20 per cent of the amount in cash.

House Wiring Coupon.

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Houses must be adjacent to our lines, and completed and occupied. No discount in excess of $10 per house will be allowed.

MOBILE ELECTRIC COMPANY

THEO K JACKSON, General Manager. Telephones: Bell 3185; Home 22. 11 N. Royal St.

FIG. 1. FOUR ADS. WERE USED; THESE ARE THE FIRST AND LAST ONES.

The total amount of the contracts let was $2,467.90, which is an average of $29.73 per contract. These contracts called for an aggregate of 971 outlets, making an average of 11.5 outlets per house, which means approximately a gain in connected load of 1000-16 c. p. equivalents. Of the contracts taken, only three were under $10.00, so it will be seen that a good class of houses were wired. One house with 80 outlets was wired and several jobs came to over $50.00. One contractor secured 45 out of the 83 contracts —he is also "powerful strong on ducks."

These results are especially gratifying in view of the fact that a year ago we gained 662 residence customers in six weeks by a campaign carried out along different lines, at a cost of $3.22 per customer. An analysis of the cost of the 1911 advertising campaign is interesting.

Newspaper ads, handbills, motion picture slides....	$240.50
Value of coupons redeemed	467.01
Printing of coupons	5.90
Total cost of campaign	$713.41
Cost per consumer	8.59
Cost of each coupon deposited	2.90

STORAGE BATTERY INSPECTION SERVICE.

Feeling that increased electric vehicle business could come only by satisfactory operation of the electric storage battery, we sent our power solicitor to the factory of the Electric Storage Battery Company at Philadelphia, where he spent two weeks in going over the details of electric battery care. Upon his return a series of advertisements copies of which are shown herewith, were used in the daily newspapers. They are self explanatory.

Electric Auto Batteries

Should Give Perfect Service

The intelligent care required by machinery of any kind is all that is necessary to obtain entirely satisfactory results from modern electric auto batteries.

For the benefit of electric vehicle owners---pleasure, utility or commercial cars---the Mobile Electric Company will inspect batteries and render advice to owners free.

Our experts have made a special study of auto batteries. They will instruct present or prospective owners in the proper care of these durable and reliable apparatus.

They will explain the cause of any battery trouble and how to avoid complications in the future; where to have repairing done, etc.

Telephones---Bell 3185, Home 22

MOBILE ELECTRIC COMPANY

FIG. 2. A BATTERY INSPECTION SERVICE ADVERTISEMENT.

This service seems to fill a long felt want, for as a result of it five old vehicles have been put back into commission and four new machines have been sold. Our service includes regular inspection of batteries and electrical instruments on the vehicles, and wherever possible our man makes little repairs. Any trouble of sufficient size is turned over to the garages which are co-operating with us and our battery inspector has been of considerable assistance to these garages in showing their men how to care for the batteries. One garage has sent out of town for a battery expert to take care of this end of their business. The service on our part has put electric vehicle operation on a satisfactory basis and made every electric owner in Mobile a steadfast friend of the company.

1910 HOUSE WIRING CAMPAIGN.

In view of the fact that the data given for our 1911 wiring campaign represents the second time of raking over the field, it may be of interest to briefly review the work of the 1910 campaign, or the first one. The campaign is briefly outlined in the full page newspaper advertisement, cut of which is shown herewith. The preparatory work for this campaign consisted of getting competitive bids from each contractor in town, on wiring a five room house taken as a standard. After having obtained these bids we satisfied ourselves that the figures were based on the cost of labor and material and made arrangements with the lowest bidder for paying him $1.50 on each proposition A; $2.00 on each proposition B; $2.50 on each proposition C, as his profit, showing him that he could afford to take a large amount of business at a small cost during a naturally dull season.

At the outset we divided the city into four sections and gave each solicitor credit only for contracts coming from his territory. We offered any solicitor $25.00 who would bring in 100 contracts during the campaign. It was only a short time until three of the four men had done this and we then offered an additional premium of $100.00 if the total number of contracts was brought up to 600 by the expiration of the six weeks. This money was to be prorated among the solicitors according to the number of contracts secured. The premiums stirred up a great deal of friendly

Homes Wired for Electric Light at Actual Cost

We Pay the Contractor's Profit

This Offer Will Close November Fifteenth

Why We Do It

Electricity in the home is rapidly becoming universal. The low rate now in effect places electric lighting within the reach of every family of moderate means.

The only reason why EVERY FAMILY does not use electricity is because many homes are not wired and equipped for the service.

The success of our business depends upon selling the largest possible output at the lowest possible price.

Therefore, we are willing to co-operate with citizens in equipping their homes for electric lighting, and to help them bear the cost of installation.

We have made arrangements to wipe out absolutely all contractors' profits and some of the other expense by simply paying these costs ourselves. The difference is a gift to every householder who accepts our special proposition.

NO AGREEMENT OF ANY KIND TO USE ELECTRIC SERVICE IS REQUIRED.

What Is Done

The Mobile Electrical Supply Company, 71 Dauphin Street, wires your home and equips it with fixtures, shades and lamps.

The job will be modern, safe and efficient. The cheapest proposition does not mean skimping or inferior materials. You may have ADDITIONAL FIXTURES, lamps, shades, domes, etc., by paying more money, but all AT COST.

Houses with more rooms than figured in the standard propositions will be taken at prices proportionally higher.

All wiring will be concealed in the floors and walls, unless building construction prevents it.

House wiring enables not only enjoyment of electric lighting, but of electric flat irons, fans, water heaters, toasters, sewing and washing machine motors, etc., etc., as well.

Owing to the cost of this proposition to our company it is restricted to houses on or adjacent to our distributing lines.

Standard Propositions

Proposition A

Wiring complete with lamps	$8.00
Underwriters' inspection fee	1.00
	$9.00

Complete wiring for five-room house—five drop cords, five ornamental glass shades, five incandescent lamps. This will supply lighting for parlor or living room, dining room, kitchen and two bed rooms.

Proposition B

Wiring complete with lamps	$10.75
Underwriters' inspection fee	1.50
	$12.25

Complete wiring for five-room house—two two-light fixtures; three drop cords; six ornamental glass shades; seven incandescent lamps. This installation will give two lights in the living room and two lights in the dining room, one in each of the others.

Proposition C

Wiring complete with lamps	$12.50
Underwriters' inspection fee..	1.50
	$14.00

Complete wiring for five-room house—square brass tubing fixtures, instead of drop cords; wall fixtures where desired; two fixtures have two lights each, the others one. Shades richly ornamented. This gives a really artistic installation of seven lights, the lamps being included in price.

More extensive and elaborate installations at prices in proportion. Apply to our New Business Department for TERMS and further particulars. Telephones—Bell 73, Home 22.

Mobile Electric Company

FIG. 3. ADVERTISEMENT USED DURING 1911 CAMPAIGN THAT PULLED BUSINESS.

rivalry and resulted in a total of 662 contracts. A careful record of the contracts taken and the conditions of each was kept and afterwards served as a check on the contractor and enabled us to see that every contract taken was filled. This also gave us a check on the prompt installation of meters upon the completion of the work.

The cost of this campaign was as follows:

Contractor's profit	$ 965.50
Salaries (four men)	393.50
Prizes	175.00
Newspaper advertising	586.67
Circulars, etc.	17.00
	$2,137.67
Average cost per consumer	3.22

We had 4100 residences in service on October 1, 1910. This was, therefore, a gain af 16.1% in six weeks time. It is estimated that this additional business increased our gross revenue the past year in the neighborhood of $10,000.

The results secured through these campaigns has induced one of our local contractors to put on a house wiring campaign on an installed payment plan. The business is being secured through direct solicitation and by advertising the proposition quite extensively.

Mean spherical candle-power is the average candle-power given by a source in all directions.

Mean lower hemi-spherical candle-power is the average candle-power given by a source below the horizontal.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

FREQUENCY OF SYSTEMS.

Editor Southern Electrician:

(291) In looking over a manufacturers motor catalog, I note that 3-phase motors are carried for frequencies of 25, 40, 50 and 60 cycles. Does there seem to be any possibility toward standardizing on 25 and 60 cycles? What are the particular advantages of 40 or 50 cycle operation? S. R. W.

CHANGING D. C. GENERATOR TO A. C.

Editor Southern Electrician:

(292). I have a direct current generator with six poles, double series winding and 28 commutator segments. What three commutator segments must be tapped to get three-phase current? Give diagram of connections.

L. H. W.

POWER FACTOR OF SYNCHRONOUS MOTOR.

Editor Southern Electrician:

(293). Kindly publish a formula for determining the power factor of a three-phase synchronous motor from meter readings at the motor. Solve the following case, volts 3600, amperes 39, k.w. 250. Also give vectorial diagram showing the phase relation between synchronous motor and line factors. What size of copper wire can be used as a temporary fuse at 40 and 150 amperes and 125 and 250 volts? A. C. H.

WATTMETERS ON LOW POWER FACTOR CIRCUITS.

Editor Southern Electrician:

(294). When two single phase recording wattmeters of the induction type are used to measure the power on a three phase circuit, where the power factor varies above and below 50 per cent, will the sum of the readings of the meters represent the power consumed through the circuit? With operating conditions on the circuit practically the same, how do you explain these readings: First month, meter No. 1, 25 k.w, No. 2, 8 k.w. Second month, meter No. 1, 60 k.w., No. 2, 25 k.w. R. R.

WHY IS 25 CYCLES ADOPTED BY HYDRO-ELECTRIC COMPANY?

Editor Southern Electrician:

(295). Several of the large hydro-electric transmission companies have adopted 25 cycles as standard frequency. Will some reader give the main reasons for such a decision and compare 25 cycle operation with 60 cycle for large systems running lines long distances. L. A. T.

SPACING OF WIRES ON DISTRIBUTION SYSTEM.

Editor Southern Electrician:

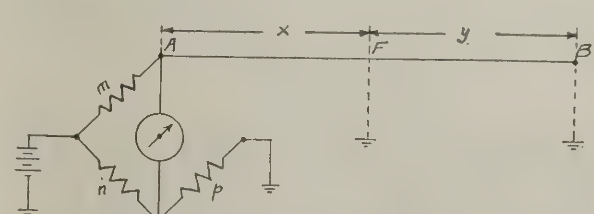
(296). Why are the three wires of a low voltage distribution system often spaced unevenly, many times two of the wires on one side of the cross arm about 18 inches apart with the third on the opposite sides? Is this arrangement for electrical or mechanical reasons? H. E. G.

EXPLANATIONS OF EARTH OVERLAP METHOD BRIDGE TEST.

Editor Southern Electrician:

(297). Please give full explanation of the earth overlap method bridge test in the question and answer columns. The sketch shown here gives the nature of connections. The letters *M*, *N* and *P* indicate the three arms of the bridge. A-B is the line or cable pair in trouble at point F. The bridge is first connected at point A and a balance taken with the distant end grounded. The bridge is then disconnected and connected at B, in the same way, and balance taken with the point A grounded. I believe this is a standard test for the location of high resistance faults where there is no available good wire, and is used on the location of all submarine cable faults. What I desire is for some one to check this information and furnish detailed information on the formulas used with the test, showing all steps.

E. R. H.



Connections for Earth Overlap Bridge Test.

Size of Power Cable, Ans. Ques. No. 273.

Editor Southern Electrician:

One of the most satisfactory ways of determining cable sizes for a particular case is through use of the following table. This table is based on the assumption that there shall be no more than four equally loaded underground cables in the usual type of conduit system in adjacent ducts and that the initial temperature does not exceed 70° F. A power factor of 100 per cent is also assumed. If the power factor is less than 100, the power carrying capacity in actual kilowatts is correspondingly reduced, while the apparent power or kilovolt amperes remains unchanged. In the use of the table, it is merely necessary to read off directly the size of conductor required from the conditions of the case. Suppose it is desired to transmit 2000 kilowatts at 11,000 volts. Under the 11,000 volt column it is seen that a No. 1, B. and S. conductor will carry 2,088 k.w., hence this is the cable required.

RECOMMENDED POWER CARRYING CAPACITY IN KILOWATTS OF DELIVERED ENERGY, THREE CONDUCTOR, THREE-PHASE CABLES.

(*From No.* 17 *Handbook Standard Underground Cable Co. Copyright* 1906.)

Size in B & SG	Volts 1100	2200	3300	4000	6600	11000	13200	22000
	Kilo-watts							
6	92	183	275	333	549	915	1098	1831
5	109	217	326	395	652	1087	1304	2174
4	130	260	390	473	781	1301	1562	2603
3	154	309	463	562	927	1544	1854	3089
2	179	358	536	650	1073	1788	2145	3575
1	209	418	626	759	1253	2088	2506	4176
0	240	481	721	874	1442	2402	2884	4805
00	279	558	836	1014	1674	2788	3347	5577
000	322	644	965	1172	1931	3217	3862	6435
0000	372	744	1115	1352	2231	3717	4462	7435
25000	413	827	1240	1503	2480	4132	4960	8264

This method does not take into account the question of drop. The price of the wire from the standpoint of drop depends upon the difference in the drop allowable in any particular case. However, for relatively short distances and fairly high voltages, the current carrying capacity determines the size of conductor rather than the consideration of drop and the current carrying capacity being the determining feature for longer distances as the voltage increases.

S. S. WARNER.

Size of Motors for Pumps, Ans. Ques. No. 277.

Editor Southern Electrician:

In question 277, F. W. T. does not give enough data regarding his problem to solve it. He does not say what type of pump he is using, but we will assume it of the triplex type. This type of pump can be used equally well with direct or alternating current motors. If starting conditions are such that the starting torque is excessive, the pump can be equipped with a by-pass so that the liquid will circulate through the pump cylinders when starting, without going through the discharge pipe and thus will keep the load down until the motor gains speed, when the by-pass can be cut out. If he has a choice of either direct or alternating current the possibility is that a compound-wound, direct current motor will meet his requirements best, but he can use an alternating current motor of the slip ring type with starting resistance in the rotor circuit.

C. H. CLARK, Engineer for Gould Pump Co.

Size of Motor for Gould Pump, Ans. Ques. No. 277.

Editor Southern Electrician:

If F. W. T. has a choice between A. C. and D. C. for operating his pumps, I shall advise the adoption of the D. C. unit. The pump having to work against a full discharge pipe will demand a maximum starting torque from motor. Acceleration in a D. C. motor with maximum torgue is more steady, that is in current demand than the A. C.

If a D. C. unit is decided upon, a compound motor should be used. A. C. motors could of course be used but the current demand under full load torque is very large. A motor of the coil wound rotor type and external resistance would be necessary. If the pump were of centrifugal type and arranged so that they did not deliver water until very nearly up to full speed, then the squirrel cage type of A. C. motor could be used.

G. I. MORGAN.

Tungsten vs. Carbon Lamps, Ans. Ques. No. 278.

Editor Southern Electrician:

Replying to question 278, it is not possible for H. A. P. to get a tungsten lamp of 16 candle power, the nearest being 25 watt or 20 candle power. I have at present a 16 candle power carbon lamp and a 25 watt tungsten connected to a 5 ampere wattmeter, it being my intention to allow them to burn until burned out. They have now been in circuit slightly over 1000 hours, and for that time the results are as follows:

Style of of lamp.	C. P.	Watts.	Cost of lamp.	Cost per hr. for 1000 hrs.	K. W. hrs. consumed.	Cost per K.W. hr. at 10c per K.W. hour.	Total cost per hour.	Cost for 1000 hrs. including lamp
Carbon	16	60	20c	.0002	60	.006	.0062	$6.20
Mazda	20	25	60c	.0006	25	.0025	.0031	$3.10

GEO. ALLEN.

Tungsten vs. Carbon Lamps, Ans. Ques. No. 278.

Editor Southern Electrician:

In answering question 278, the following conditions will be assumed in addition to those given. The rate for current will be 10 cents per k.w hr. with $2.00 the minimum, with 10% discount ,and carbon renewals furnished free. 25 watt tungsten furnished at 55 cents and 40 watt at 65 cents. One 16-candle power carbon lamp, so called, gives 18.3 candle power at average operating voltage, and to produce this candle power consumes 57.8 watts, or 3.16 watts per candle power.

Therefore,

$18.3 \times 5 \times 5 = 458$ candle hrs. per day.

$458 \times 30 = 13700$ candle hrs. per month.

$13700 \times 3.16 = 43500$ watt hrs. per month.

$= 43.5$ k.w. hrs. per month.

The monthly bill will then be: at 10 cents per k.w hr. = $4.35, less 10%, or $3.92.

When using 13700 candle hours per month by tungstens, the cost is as follows with the tungsten lamp operated on 1.37 watt per candle:

$13700 \times 1.37 = 18700$ watt hrs. per month.

$= 18.7$ k.w. hrs. per month.

For this consumption of current a minimum bill is rendered of $2.00. The saving per month is $3.92 — 2.00 = $1.92, or for 12 months = $23.04.

To use up to the minimum and get the benefit of the 3.3 k.w. hrs per month, 6 25 watt tungsten lamps can be used increasing from 13700 candle hours per month to 16400 per month at no additional cost.

To keep the bill at the minimum using light 150 hours per month by carbon lamps, only 2.58 lamps on an average can be used. In other words, about 2.5 times as many

tungsten lamps of same candle power as carbon can be used at same expense.

From the above computations there is a saving through the use of tungsten lamps of $23.04 per year. Since operation and renewals are to be considered and since carbons are to be furnished free, this saving will be reduced by the cost of 6 tungsten lamps, assuming that the life will be 1300 hours. According to the rate of burning of 150 hours per month two sets of lamps would burn 1.4 years, making the cost of 6-25 watt tungsten lamps per renewal $3.30 or the cost of lamps per year, $2 \times \$3.30 \div 1.4 = \$4.70$. Thus the total net saving is $23.04 — $4.70, or $18.34.

G. W. Brown.

Proper Wattmeter Connections, Ans. Ques. No. 279.

Editor Southern Electrician:

To aid in the solution of the action of the wattmeter in question 279 of the March issue, I have laid out the diagram in Fig. 1, denoting the line voltages by the triangle A, B and C. I have denoted the directions of the line current for unity power factor by the vectors O-A, O-B and O-C. An approximation of the directions of the different current at 75% power factor would be illustrated by the vectors O-F, O-D and O-E. The swapping of the potential transformer leads, as stated by Mr. Smith, would constitute a combination in one element of the wattmeter, assuming

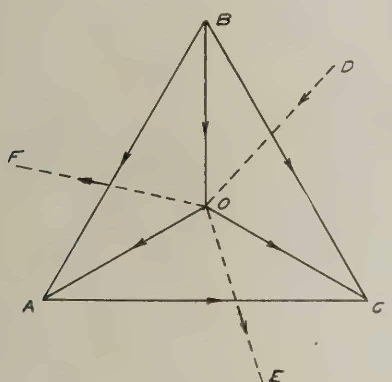


Diagram Showing Relations in Wattmeter.

unity power factor, of the current vector O-A and the voltage vector B-C. Likewise, in the other element of the wattmeter, there would be a combination of the voltage vector A-B and the current vector O-C. At unity power factor, it can readily be seen that the current coil in both elements of the meter is in quadrature with the field produced by the voltage, so that there would be no turning moment whatever, and the meter would stand still. The instantaneous directions of the currents and the voltages are indicated by arrow heads on the vectors.

Under the condition as shown for 75% power factor, the turning moment produced on one element of the meter will be that component of the current vector O-E which is in phase with the voltage vector A-B. The resultant of these two would tend to turn the meter in a positive direction. The turning moment on the other element of the meter would be that component of the current vector O-F which would be projected on the vector B-C. The torque produced by the combination of these two vectors is equal and opposite to that produced by the torque of the other element, so that if the phases were equally balanced, the meter would stand still and would not register.

If the current element O-F were reversed the torques of the two elements would then be in the same direction, and the speed of the meter would be proportional to the sine of the angle of lag; or, in other words, the meter would be converted into a watt-less component indicator, and for an angle of lag corresponding to the cosine 75%, the indications of the meter would be approximately 66% of the kilovolt amperes, as represented by the formula $E \times I \times$ the square root of three, where E is the voltage between lines, and I is the current in any one line—assuming, of course, that the circuits are balanced.

H. E. Bussey.

Unbalancing of 3-Wire, 2-Phase System and Proper Wattmeter Connections, Ans. Ques. No. 279.

Editor Southern Electrician:

Part I.—Reasons for the unbalancing of a 3-wire, 2-phase system connected to induction motors. The induction motors are doubtless 4-terminal motors with the four sections of the static winding connected either "star" or "mesh." There should be rated pressure between opposite points of the winding and rated pressure times $1/\sqrt{2}$ between adjacent points. In the 3-wire system one terminal must be left open. Assuming a star-connected motor, the connections are as in Fig. 1.

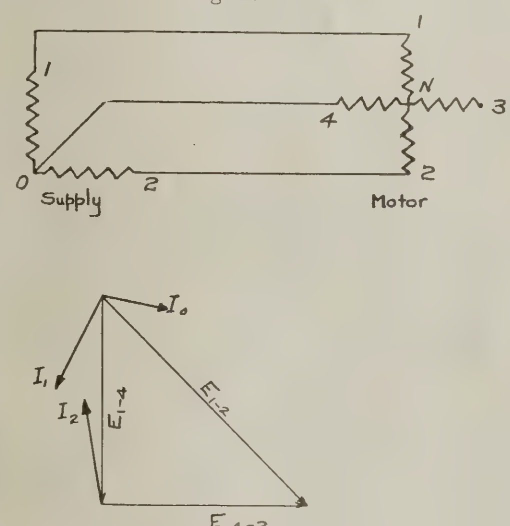


Fig. 1. Two-Phase Star Connected Motor on 2-Phase, 3-Wire System. Also Vector Diagram for These Circuits.

To terminals 1, 2 and 4, approximately the proper pressures are applied, but terminal 3 is left waving in the air. Fig. 2 shows these pressures.

To show that the phases of the motor will be unequally loaded and the system unbalanced the three-wire windings may be replaced by three equal impedances and the values and phase relations of the resulting currents calculated. Let the pressures be $E_{1-2} = 100$ volts, $E_{1-4} = 71$ volts, $E_{4-2} = 71$ volts.

Let each impedance be $Z = 6 + j8$ ohms. To take account of the vector relations of the pressures they may be expressed with reference to E_{4-2} as a reference. Then

$$E_{4-2} = 71;\ E_{1-4} = -j\,71.$$
$$E_{1-2} = E_{1-4} + E_{4-2} = 71 - j\,71. \qquad (1)$$

If Kirchoff's laws be applied to these circuits the following expressions will result:

$$I_1 = (E_{4-2} + 2\,E_{1-2})/3Z.$$
$$I_2 = (E_{1-4} + 2\,E_{2-1})/3Z.$$
$$I_0 = (E_{2-1} + 2\,E_{4-2})/3Z. \qquad (2)$$

Substituting the values from eq. (1)

$I_1 = (71 - j\,142)/3Z = (71 - j\,142)/(18 + j\,24) = 2.37 - j\,4.73 = 5.3$ amperes.

$I_2 = (-142 + j\,71)/3Z = (-142 + j\,71)\ (18 + j\,24) = -0.95 + j\,5.2 = 5.3$ amperes.

$I_0 = (71 + j\,71)/3Z = (71 + j\,71)/(18 + j\,24) = 3.3 - j\,0.48 = 3.33$ amperes.

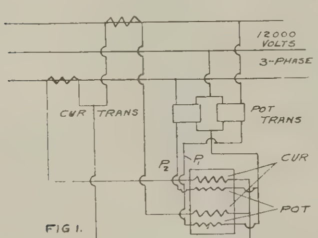
These currents are worked out in components to facilitate the drawing of the vector diagram shown in Fig. 3. The current I_0 is less than either I_1 or I_2 and the currents are not displaced 90° as is desired in this system. With three equal impedances (of 10 ohms each) connected as in Fig. 1, the writer secured the following results:

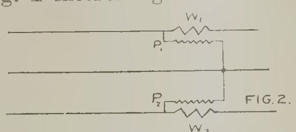
Volts						Amperes		
1-2	1-4	4-2	N-1	N-2	N-4	1	2	3
100	72	71.6	53.3	52.2	34.2	5.1	5.0	3.34

These values check roughly with the calculated values, the difference being due to the distortion of the supply pressures and inequality of the impedances.

Proper Wattmeter Connections, Ans. Ques. No. 279.

Part II. The connections of Fig. 1, question 279, which is here repeated, are equivalent to the simpler connections of Fig. 2, in which the instrument transformers are omitted. With P_1 and P_2 of Fig. 1 interchanged the simplified connections are as in Fig. 3, which shows also the source of power. With the connections of Fig. 2 the wattmeter W_1 has the current I_1 and pressure E_{2-1}. Wattmeter W_2 has the current I_3 and pressure E_{2-3}.





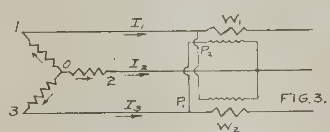


FIG. 1. WATTMETER CONNECTIONS. FIG. 2. EQUIVALENT PROPER CONNECTIONS. FIG. 3. INCORRECT CONNECTIONS, P_1 AND P_2 INTERCHANGED.

Referring to Fig. 4, showing the vector relations for a balanced inductive load, the wattmeters will read as follows:

For the correct connection (Fig. 2),

$$W_1 = I_1E_{2-1}\cos(\Theta - 30)\,;\ W_2 = I_3E_{2-3}\cos(\Theta + 30) \quad (1)$$

The total reading will be,

$$\begin{aligned} W_1 + W_2 &= EI\,[\cos(\Theta - 30°) + \cos(\Theta + 30°)] = \\ &= EI(\cos\Theta\cos 30° + \sin\Theta\sin 30° + \cos\Theta\cos 30° - \sin\Theta\sin 30°) \\ &= 2EI\cos\Theta\cos 30° = \sqrt{3}EI\cos\Theta = \text{total power.} \end{aligned} \quad (2)$$

For the incorrect connection (Fig. 3),

$$W_1' = E_{2-3}I_1\cos(90 - \Theta)\,;\ W_2' = E_{2-1}I_3\cos(90 + \Theta) \quad (3)$$

The total reading is then,

$$\begin{aligned} W_1' + W_2' &= EI\,[\cos(90° - \Theta) + \cos(90° + \Theta)] \\ &= EI\,(\cos 90°\cos\Theta + \sin 90°\sin\Theta + \cos 90°\cos\Theta - \sin 90°\sin\Theta) \end{aligned}$$

$=$ zero, or the total reading would be zero.

However, if the current coil of one wattmeter is reversed, the total reading will be,

$$\begin{aligned} W_1' - W_2' &= 2EI\sin 90°\sin\Theta \\ &= 2EI\sin\Theta \end{aligned} \quad (4)$$

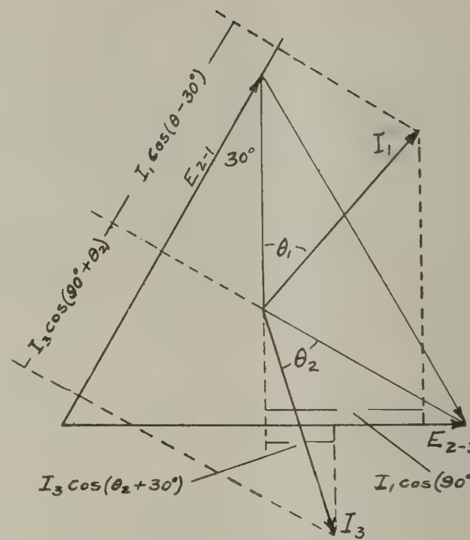


FIG. 4. VECTOR RELATIONS BETWEEN CURRENTS AND PRESSURES IN THE TWO WATTMETERS.

Assuming the various power factors and calculating the total reading of the wattmeter by equations (2) and (4) the results shown by the curves of Fig. 5 were obtained.

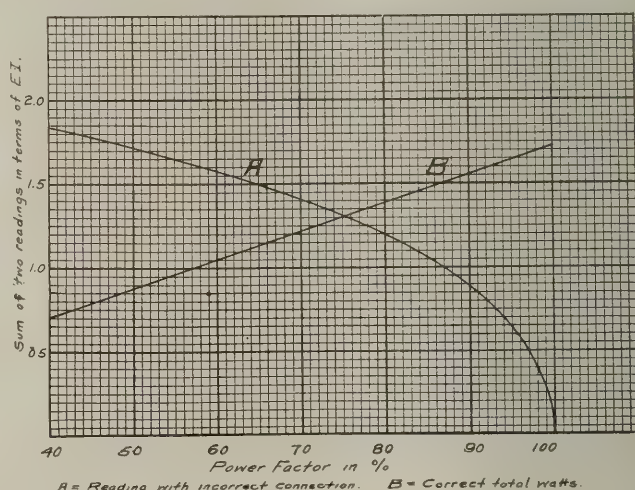


FIG. 5. READINGS WITH THE TWO METHODS OF CONNECTION.

These curves show that, assuming a balanced load, the incorrect connection would give one half the correct reading at a power factor of 50 per cent.

PROF. B. C. DENNISON.

Thawing Frozen Water Pipes.

Editor Southern Electrician:

Replying to question 282, frozen water pipes can be quickly and economically thawed with either A. C. or D. C. For A. C. special thawing transformers can be bought, but I have always used a 10 K. W. transformer with 110 V. secondaries and a water rheostat.

In thawing a frozen pipe I connect the primary side to line properly fused. Then connect the low tension leads, one to a convenient fire plug with the water rheostat in series, and the other to a faucet or water pipe in the house. Adjust the water rheostat so fuses will not blow and water will soon be thawed out. I have thawed from 130 to 150 feet of 5/8-inch lead pipe in ten minutes.

With direct current the connections are the same, omitting the transformer. I have used this method successfully

up to 550 volts D. C. and was nearly successful in using 2300 A. C. without a transformer. I would have been successful if I could have kept the water in the barrel cold.

In using the water rheostat if a little salt or commecial sulphuric acid is put in the water, the plates can be adjusted a little better than when pure water is used. I have a water rheostat, a 10 K. W. transformer, switch and fuse blocks mounted on a truck, which makes the set very convenient.

GEO. ALLEN.

Thawing Pipes, Ans. Ques. No. 282.

Editor Southern Electrician:

In question No. 282 the inquirer asked for information regarding the thawing of water pipes with electric current, and for the proper connections, also if this could be done successfully with both A. C. and D. C., and in your April issue I have noticed an answer from Mr. Fryer, which gave the proper connections for both currents, but stating that he saw no reason why it would not work with the ordinary 110-220 direct currents. Mr. Fryer should have gone further, and stated that with the proper amount of amperage, at 110 or 220 volts, it would no doubt be successful, but unless the party attempting to thaw the pipes had a machine with an exceptionally large rating, it would be such an expensive undertaking that it would not pay to make the attempt.

We have had considerable pipe thawing to do up here in Minnesota every winter, and at the present time we have an 8-inch main at a depth of from seven to nine feet, frozen for a distance of about 400 feet, and it has been my experience that with the ordinary transformer the thawing of water pipes is rather difficult and quite expensive, but with a transformer wound for low voltage, not to exceed 60, preferably 50 volts, it is a very simple and inexpensive matter to thaw them; with direct current it will be found to be quite an expensive piece of work. With a voltage of 110, and ammeter reading 300, there will be found to be very little heat in the wire, and with 220 volts, amperage remaining the same, much less heat, showing that an enormous amperage is required with a voltage of 110, and when we consider that the ordinary run of D. C. generators in use rated at 110 volts, do not exceed 400 amp. capacity, we certainly cannot maintain that D. C. is practicable for this class of work. If this party has a D. C. generator, that will at a voltage of about fifty, carry a load of from 300 to 400 amp., he can successfully thaw the pipes, but he will find that with a machine rated at 110 volts, 400 amp., he can put his electrodes together in the barrel, and operate this machine on practically a dead short, and not generate enough heat in the wire to do any good. 300 amp. at 50 volts, 500 at 110 volts, and 750 to 800 amp. at 220 volts will be about the least current application for successful pipe thawing.

GEO. A. LINDSAY.

New Apparatus and Appliances.

Electrical Pyrometers in Power Plant Service.

The value of a definite knowledge of the temperatures developed in the various units of a power plant is rapidly becoming recognized by leading engineers throughout the country, both mechanical and electrical. It is evident that the full efficiency of a plant can only be developed when the official in charge is in possession of a knowledge of the maximum power which may be developed, or the conditions under which the plant ca nbe operated most economically. With reference to steam plants this is especially true, and the knowledge of the temperature being developed under the boiler, the amount of heat which is passing through the flues, and the amount which is being permitted to pass up the stack without having accomplished some useful purpose, is bound to bring about a change in the methods of operation which will produce uniform conditions and either better results or a lower cost of operation. This is also true of the temperature of the feed water, the temperature maintained in gas producers, superheaters, economizers, and the various other items of equipment in the up-to-date power plant.

A large majority of these temperatures can be determined by means of thermoelectric pyrometers, covering all ranges in temperature from 0 to 3000° Fahr. A most complete line of pyrometers is manufactured by the Thwing Instrument Company, Philadelphia, Pa., and a convincing proof of their suitability for this class of work is the complete installation of such pyrometers made by this company in the Central Power Plant of the Washington (D. C.) Navy Yard. This equipment covers the essential temperature measurements in this up-to-date power plant, the temperature being recorded as well as indicated, the indicating instruments being placed near the various machines, for the convenience of the firemen, the recorders being placed in the office of the supervising official.

A unique feature, covered by U. S. patents, embodied in this line of instruments, enables the Navy Yard officials to gather the information from a large number of points, in similar instruments, on a single recorder, rather than forcing them to install a large number of single record recorders. Thus sixteen records from Green Economizers are collected in the office on two eight-record recorders, while two indicators and two eight point switches enable the firemen to determine the temperature of any economizer at stated intervals. At the same time, another eight record recorder is giving actual temperatures of the water in the economizers, while a four record recorder gives the temperatures of the superheaters. Thus twenty-eight records, all absolutely distinguishable, are secured on four recording instruments, eliminating a large amount of time and labor which would be required in the care of 28 instruments, securing the advantage of having comparative records of similar machines on one chart, preventing the danger of mistakes in filing, properly labeling, etc.

Temperatures under the conditions outlined above can be secured through the use of patented base metal thermocouples, as may also the temperature in the stacks, in the gas producing machines, and other line types of machinery. The temperatures in the fire box under the boiler are often times above the limit of durability of thermocouples, and even if not, are in a position where the use of thermocouples is not practicable. For this work, and similar condi-

tions, the Thwing Radiation Pyrometer is especially adapted. This instrument is not inserted into the heat, but the temperature is measured by direct radiation. It is said to be highly accurate, very convenient to use in its portable form, requiring no focusing, and reaching a true determination of the temperature in less than five seconds. This instrument has been given severe tests in demonstrating its adaptability to the measurement of boiler temperatures, and has proved its efficiency. Its use, combined with that of a thermoelectric pyrometer for flue gas temperatures, will enable the user to closely control his firing temperatures, developing power with a higher degree of efficiency.

The Maxicator.

An instrument for converting the ordinary meter into a maximum indicating and watthour meter is being manufactured by the Chicago Electric Meter Company and distributed to the trade by the Minerallac Electric Co., of Chicago. The Maxicator is a combination of maximum demand indicator and watthour meter register and takes the place of the original register on the watthour meter. It has four dials, similar to those of the watthour meter register, from which to obtain the reading of total consumption, but in addition is equipped with a larger center pointer which indicates on a scale on the margin of the dial plate, the maximum demand during a half hour interval over any period, such for instance as a week or month. This larger hand constitutes merely a friction pointer, the friction being obtained by means of a leaf spring bearing against the shaft. This maximum indicating pointer is carried forward by means of a driving "set back" pointer connected directly by gearing with the register movement. This "set back" element is controlled by means of a solenoid mounted on the back of the register as shown in Fig. 2 and connected to the gearing through a rack and pinion.

Energization of the solenoid from the line by means of a contact making motor, shown in Fig. 3, draws the plunger up to its seated position and revolves the driving pointer to zero. The factor which formerly prevented the application to a meter of a device performing functions similar to those of the Maxicator, was the excessive friction intro-

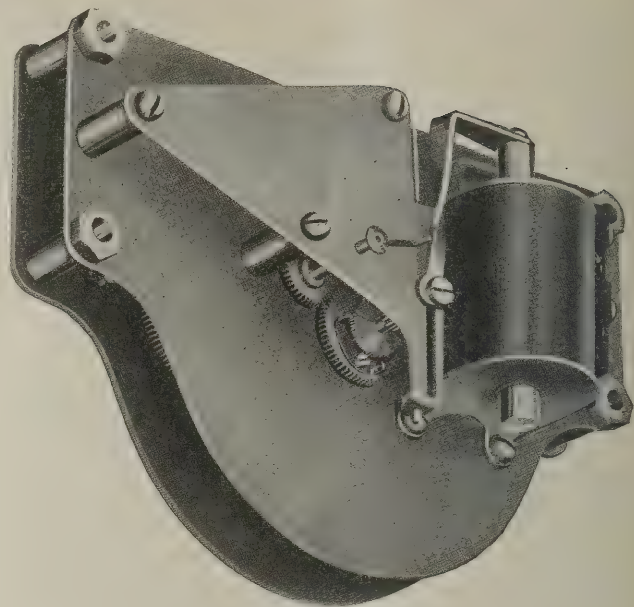


FIG. 2. BACK OF MAXICATOR.

duced. The Maxicator, however, by means of gravity and the escapement principle, has entirely eliminated this disadvantage. To prevent this additional load being imposed on the meter, the plunger of the solenoid which is raised at the end of each thirty minute interval—to set back the driving element to zero—descends during the next succeeding interval, thus furnishing the power necessary to drive the entire register movement, the meter acting only as an escapement in regulating the speed of falling.

This indicating hand will always remain in the position to which it is carried until a higher reading is obtained during a subsequent thirty minute interval, the driving element alone being set back, thus leaving the indicating hand at the highest point reached during the week or month. At the end of a week or month or any length of time for which the maximum is desired, the indicating hand may be set back to zero. This operation should be performed by the meter reader.

A complete installation of the Maxicator includes one Maxicator and one contact making motor, as shown in Fig. 3. This motor is of special design and is made exclusively for use with the instrument shown in Fig. 1 and these two parts together constitute the complete Maxicator.

FIG. 1. FRONT OF MAXICATOR.

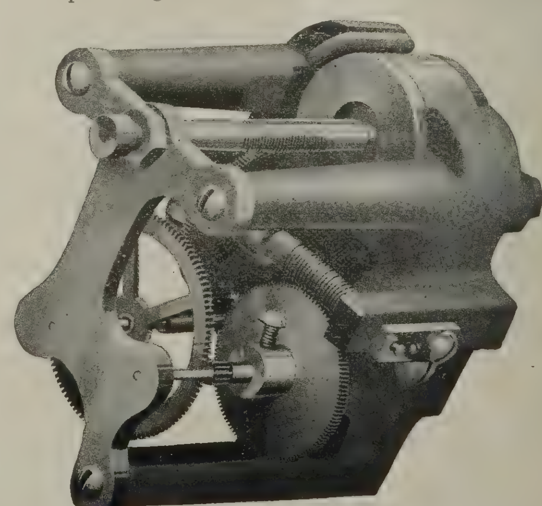


FIG. 3. MOTOR ELEMENT OF CONTACT MAKING MOTOR.

The contact making motor is composed of a single phase, 220 volt, self-starting induction motor, which is operating at practically no load, thus giving a uniform speed at all times. Through a train of reduction gearing a speed is obtained upon the last spindle of one revolution every thirty minutes, the contact element being directly connected to this spindle. A motor of this type will run continuously without attention for approximately two years, thus doing away entirely with the former complications introduced in connection with the timing element. The Maxicator as furnished is to be used with a time interval of thirty minutes and is not applicable to any other interval.

Separable-Cap Attachment Plugs.

In some cases the porcelain or porcelain-cap attachment plug is not suitable because of liability of breakage. The two separable-cap attachment plugs illustrated herewith have been developed to overcome this disadvantage. The caps of both are made of the tough insulating material which has been developed for the Cutler-Hammer line of switch specialties. The plug shown in Figure 1 has a porcelain base and that in Figure 2 has a composition base

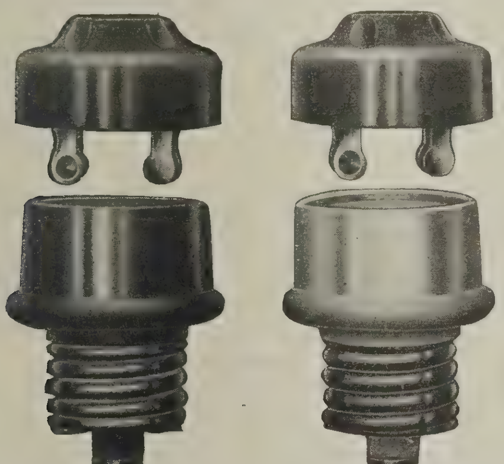


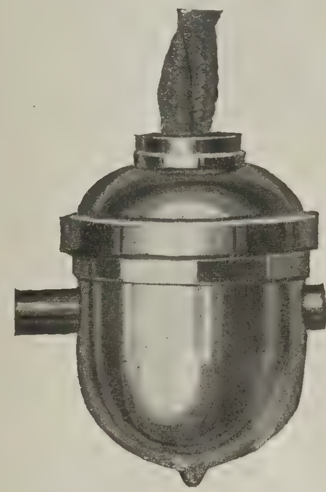
Fig. 1. Attachment Plug with Porcelain Base and Cap.
Fig. 2. Attachment Plug with Composition Base and Cap.

and cap. The design of the contacts of these plugs allows the separation of the cap by a pull in any direction whatsoever. Side strains on the fixture, receptacle or socket are therefore avoided. The rating of each is 660 watts, 250 volts. They have both been approved and listed by the Underwriters' Laboratories and have been placed on the market by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis.

A New Pendent Switch.

A new brass shell pendent switch has been placed on the market by the Cutler-Hammer Manufacturing Company of Milwaukee. The shell, fashioned like an acorn, is about 1¾ inches in height and the weight of a complete switch is less than two ounces. The removal of the cap (which is held in place by a snap lock) reveals a simple but rugged interior mechanism operated by a straight push-bar, similar to that used in Cutler-Hammer porcelain pendent switches. Ample terminal space is provided for wiring and the Underwriters' label testifies to the fact that the new switch has successfully met the rigid requirements of the Underwriters' Laboratories.

The "Acorn" switch operates with a quick snap and the whole of the operating mechanism, except the projecting push buttons, may be concealed under a half-dollar. No porcelain is used in the construction of this switch, a new insulating material, developed in the ceramic labora-



A New Cutler-Hammer Pendent Switch.

tory of the Cutler-Hammer Mfg. Co., being used for supporting the operating mechanism. The new material is said to be unbreakable under ordinary service conditions and can be molded with much greater accuracy than porcelain, insuring proper alignment of parts and smoother operation when the switch is assembled.

New Greenwood Sign for Appalachian Power Company.

The accompanying illustration shows a sign now being manufactured by the Greenwood Advertising Co., of Knoxville, Tenn., for the Appalachian Power Co., of Bluefield, W. Va. This sign to be erected on a mountain side opposite the city of Bluefield, and is 130 feet long by 44 feet high. The letters are eight feet high and will be made up of 1200 5-watt Mazda lamps. The installation of this sign represents the progressiveness of the H. M. Byllesby Co.'s properties, those of this particular organization pushing these progressive ideas being H. W. Fuller, vice-president and general manager, and T. M. Combitts, new business manager. Vice-president J. E. Tucker of the Greenwood Company advises that the Byllesby organization has another large sign under construction at the factory for St. Paul, Minn. This sign will be 30 by 50 feet and erected on the St. Paul Hotel.

Electric Sign to be Erected at Bluefield, West Va.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

BIRMINGHAM. According to reports the American Radiator Co., of 816 S. Michigan Ave., Chicago, Ill., is to construct a hydro-electric plant on the Cahava River at a cost of between one million and two million dollars.

BIRMINGHAM. The Tide Water Power Co., has filed application for a charter for the purpose of supplying electricity for lighting and power purposes in Birmingham, Bessemer, Brookwood, Tuscaloosa, Gadsden, Attalla, Alabama City, Ashville, Springfield, and other towns. The incorporators are J. M. Dewberry, Pres., R. E. Johnson, Jr., Secy.

CHEROKEE BLUFFS. The Alabama Traction, Light and Power Co., has engineers at work determining the location of their first development. It is understood that this development will be located at Cherokee Bluffs and will be of such a nature that 100,000 H. P. will be generated. The investment will be about $6,000,000 and the ultimate plans of the company includes the building of a lock known as No. 18 on the Coosa River twenty miles from Montgomery and another at the shoals near Florence and Sheffield. Transmission lines will be extended to Nashville and Memphis, Tenn., West Point, Meridian and Jackson, Miss., Mobile, Huntsville and Decatur, Ala., and the ultimate development of the system will be 400,000 H. P. According to the present organization the Alabama Traction, Light and Power Co. is the holding corporation, controlling the Alabama Interstate Power Co., the Coosa River Power Co. It is believed further that this company is a part of the Southern States Securities Co., Ltd., of London, England. The president of the company is Lawrence McFarland of Montreal, Canada.

GADSDEN. The Noccalula Railway, Light & Power Co. is planning to build an electric railway from Gadsden to Noccalula Falls, a distance of three and a half miles.

MONTGOMERY. The Alabama Interstate Power Co. has recently announced that work on a water power plant to be constructed on the Coosa River will be undertaken in the near future. The other developments will be located on the Tallapoosa River, the system being designed to furnish power to Birmingham. The plans for the station on the Coosa River near Wetumpka are being prepared. James Mitchell is president of the company.

FLORIDA.

FORT PIERCE. The city council is about to make contracts for supplies for its electric lighting system and for equipment to be installed in its station. This additional equipment will include two Duplex pumps, a 250 H. P. boiler, one 100 Kva. generator, one 50 Kva. A. C. generator.

GAINESVILLE. It is understood that the city has sold $125,000 in bonds, of which $60,000 will be used for a building or acquiring of an electric light plant.

TAMPA. H. M. Sanford, Manager of the Tampa Bay Hotel, is receiving bids for the installation of an electric light plant at the hotel.

GEORGIA.

AMERICUS. Permission has been given the American Gas & Electric Co. by the State Railway Commission to issue $100,000 in capital stock and $350,000 in bonds. The company is allowed an issue of $100,000 in stock and $275,000 in bonds to pay for the present properties. $15,000 in bonds will be sold for immediate improvements and extension.

BAXLEY. Bids will be received by the city of Baxley until May 3d for the construction of a power plant and the installation of machinery for water works and electric light plant. W. W. Lyon is consulting engineer, 305 Duval Bldg., Jacksonville, Fla.

CORNELIA. The Wofford Shoals Light & Power Co. of which J. A. Wells is general manager, will construct an auxiliary crude oil or producer gas plant of 150 H. P. capacity at Cornelia, for the purpose of carrying a day load. This company plans later to construct a hydro-electric plant on Nancy Town Creek, near Cornelia, erecting a concrete building 30 by 40 feet and constructing a hollow reinforced concrete dam 30 feet high, sufficient to develop 500 H. P. Information can be obtained from Mr. J. A. Wells at Cornelia.

CUTHBERT. Plans are under way for enlarging and improving the light and water plant of the city. About $20,000 will be expended.

DALLAS. The lighting plant of the Dallas Light & Power Co. has been leased to Gordon Simons for a period of twelve years. Improvements will be made and an effort is being made to control the Paulding County Electric Co., which owns water power outside of Dallas.

FITZGERALD. It is understood that contracts have been made for the installation of an ornamental street lighting system in the business district. Forty lamp standards carrying five lamps each will be erected.

HELENA. It is understood that a street lighting equipment will be installed at Helena, operated by the plant at McRae, Ga.

MACON. The Central Georgia Transmission Co., controlled by the Central Georgia Power Co., has applied to the State Railway Commission for approval of a bond issue of $4,500,000. It is the purpose of the company to erect transmission lines from Macon to Atlanta in the vicinity of Lakewood Heights and erect a sub-station to distribute electricity in Atlanta.

MANCHESTER. The city is to construct in the near future a lighting plant, installing the necessary equipment. J. B. McCrary & Co. are engineers, and bids will be open for machinery until May 1st.

MONTICELLO. The City will vote on May 6th for an issue of bonds to the extent of $7,000 for the purpose of building an electric light plant.

VALDOSTA. It has recently been announced that the Municipal Service Co., of which H. C. Hartman is president, will expend about $200,000 in enlarging the ice, electric light and power plant which it has just purchased from the Consolidated Ice & Power Co.

KENTUCKY.

BOWLING GREEN. It is understood that the Kentucky Public Service Co., which has recently taken over public utilities of Bowling Green and other Kentucky cities, is making improvements and a contract is about to be let for 1000 K. W. turbo-generator together with other equipment.

GREENVILLE. The Greenville Light & Water Co. will construct a power house transmission line from Greenville to Central City, Ky. This line will furnish electric power to mines and several mining towns.

LANCASTER. The Dix River Power Co. has recently been incorporated with a capital stock of $3,000,000 for the purpose of developing electrical water powers on the Dix River in Garrard County near Lancaster. The construction of its plant will be begun in the early future and Arthur Giesler of New York has been engaged as engineer. L. B. Herrington of Richmond, Ky., is president of the company and also heads the Richmond Lighting Co. It is understood that the company plans to supply electrical energy to towns in the immediate vicinity and also to Lexington, Louisville and Cincinnati.

SUMERSET. The new management of the United Water, Light and Traction Co., of Sumerset, is planning to make improvements to the power house, installing additional machinery.

LOUISIANA.

BATON ROUGE. The Suburban Electric Co. has been organized with a capital stock of $250,000. This company will take over the franchises for a street railway line from the business district into North and South Baton Rouge.

LAFAYETTE. The Louisiana Electric Railway & Power Co., has recently been organized with a capital stock of $2,000,000. The company will erect an electric light plant and construct a railway system. It is understood that the main station will be located at LaFayette with relay stations at New Iberia and Abbeville. The president of the new organization is A. G. Barrow of New Iberia, La. The vice president is E. H. Campbell, of New Orleans, La. The electrical engineer is Anderson Ossbut of New Orleans, La.

LOCKWOOD. The organization of a company to establish an electric light plant, ice plant and water works system is being prompted by A. V. Smith.

MISSISSIPPI.

BILOXI. It is understood that the city is contemplating the erection of an electric lighting plant. The committee considering this proposition is composed of I. Heighenheim, John Kennedy and other councilmen.

BOONEVILLE. It is understood that R. C. Huston of the Exchange Bldg., Memphis, Tenn., is preparing plans for an electric light plant and water works system for this place.

CRYSTAL SPRINGS. It is understood that the city will make extensive improvements to the electric light plant. A bond issue of $10,000 has been voted.

HATTIESBURG. The Riverside Brick Mfg. Co. desires prices on electrical fixtures.

HATTIESBURG. A company has been incorporated by C. C. Tuerin, E. E. Esslinger, and others, known as The Central Electric Co. This company proposes to operate a plant in Hattiesburg.

SUMNER. The city is considering the issue of $22,000 in bonds for an electric light plant.

TYLERTOWN. A franchise has been granted to J. C. Flippen and C. H. Stevens for the purpose of constructing and operating an electric light plant.

YAZOO. It is understood that the Public Service Commission of Yazoo is in the market for apparatus, including steam turbine driven alternating current units, exciter units, railway converters, motor generator sets, condensers and other apparatus for its power plant.

NORTH CAROLINA.

ASHEVILLE. The Asheville Light & Power Co. has been incorporated with a capital stock of $2,000,000. This company will acquire the Asheville Electric Company's properties from the Carolina Light & Power Co. of Raleigh, N. C. These properties include electric lighting equipment, eighteen miles of railway, gas plant and main, steam power plant, together with a 200 horse power water plant, turbines, etc. This company previously purchased electricity from the North Carolina Electrical Power Company's hydro-electric plant.

CHARLOTTE. An application has been made for a franchise to construct and operate a central electric light, power and heating plant, by J. R. Purser.

GREENSBORO. The Atkin River Power Co. is considering the purchase of the municipal electric light plant. The company plans to erect a distributing sub-station. The general manager is H. Ware of Raleigh, N. C.

WILMINGTON. Julius Davis desires prices and information on isolated lighting plant for a country home.

TENNESSEE.

NASHVILLE. The Tennessee Railway, Light & Power Co. has recently been incorporated to control the Nashville Railway Light & Power Co., the Chattanooga Railway & Light Co., the Eastern Tennessee Power Co., and other water power interests. A 20,000 H. P. development is now in operation on the Ocoee River at Parksville, Tenn., at which point about 15,000 H. P. will be immediately installed. A second development will be constructed producing 16,000 H. P., giving a total of 51,000 H. P. at this point. A third site on the Ocoee is capable of producing 30,000 H. P., and a further site at Great Falls on the Caney Fork River 80 miles from Nashville is capable of developing 80,000 H. P. Transmission lines will be constructed to Nashville, Chattanooga, Knoxville, Rome, Ga., giving a total of approximately 400 miles of line. It is understood that the H. M. Byllesby & Co., of 206 LaSalle St., Chicago, is interested in this merger.

MEMPHIS. It is understood that J. R. Ellis, 305 McNeill St., would like prices on electric fixtures.

SHELBYVILLE. The Duck River Power Co. has recently increased its capital stock to $100,000. It is the plans of the company to push the work on the construction of its water power project on Duck River, which have recently been begun. The estimated cost of these plants will be $100,000. The president of the company is J. F. Boyd.

TEXAS.

AUSTIN. A company has recently been organized, known as the City Water Power Co., of Hartford, Conn., and a permit has been granted for this company to do business in Texas. Further, the city of Austin has entered into a contract with the Hydraulic Properties Co., of New York, for the construction of a dam across the Colorado River and for the installation of a hydro-electric plant. It is understood that the City Water Power Co. has been organized with a capital stock of $200,000. H. B. Freeman, Jr., of Hartford, is president and Charles S. Roberts, of New Haven Conn., is secretary. The Austin representatives of the company and the engineer on the work is Mr. Frank S. Taylor.

FORT WORTH. The Texas Traction Co. is considering the construction of a dam across the Washita River in Oklahoma, and the building of a hydro-electric plant for supplying power to operate their lines.

BOOK REVIEWS.

DESIGN OF ELECTRICAL MACHINERY, in three volumes. By William T. Ryan, Asst. Professor of Electrical Engineering, University of Minnesota. Published by John Wiley & Sons, New York City. 109 Pages. Price $1.50.

Volume I of this work, just from the press, takes up the design of direct current dynamos. Vol. II now in press is devoted to alternating current transformers, while Vol. III takes up Alternators, Synchronous Motors and Rotary Converters. The work is primarily intended for students in electrical courses, yet the practical nature of the first volume indicates that the author had in mind its usefulness to others interested in the subject of electrical design. The fundamental principles of mechanical and electrical design are set forth in the beginning of the volume, followed by many designs of parts and the complete calculations for a direct current generator. No work at present compares in clearness and brevity with this one; this is sure to be appreciated by its readers.

THE ELEMENTS OF ELECTRICAL TRANSMISSION, by Olin Jerome Ferguson, Associate Professor of Electrical Engineering in Union College. Published by the Macmillan Company, New York City. 450 pages, many illustrations, curves and tables. Price $3.50 net.

The title of this work would lead one to infer that simply a running description and brief treatment is given to the many phases of present day practice in the transmission of electrical energy. This, however, is far from the case as a casual glance through the work at once reveals. The author has in every sense presented a noble treatment of his subject in a strictly engineering style. Complicated and higher mathematics are fortunately omitted and the whole treatment has a consulting flavor. Although there are many excellent works on the market treating in a broad way and also specifically, transmission subjects, unquestionably this work presents the most comprehensive treatment of the subject and the most vital information, both general and analytical, on line construction, circuits, generation, transmission problems, distribution and line phenomena to be found in any single work of which we know. The number of pages the work contains is no index of the nature of the treatment, so compact is the make up, many similar works having been spread over twice the space. What we can say in these few remarks cannot do justice to Mr. Ferguson's contribution to the electrical profession. We therefore feel that when we say that in our opinion it should be in the hands of every electrical engineer connected with a transmission system, large or small, that we are not complimenting the author, but permitting readers of these remarks to take advantage of material that will be invaluable to them as a source of every day information.

The contents presents an excellent index to the value of the material presented: (1) CONDUCTORS AND INSULATION.—Wires: copper, aluminum, iron, sizes and properties. Cables: insulation, armor. (2) INSULATING SUPPORTS.—Line: glass, porcelain. Entering: Oil, porcelain. (3) POLES AND TOWERS.—Wooden poles, pins, etc., preservative treatment. Concrete poles, steel poles, and towers, types, etc. (4) AERIAL LINE CONSTRUCTION.—Methods and accessories. (5) UNDERGROUND LINE CONSTRUCTION.—Conduits: types, laying, roddinng, drawing-in, etc. (6) SWITCHBOARDS AND PROTECTIVE DEVICES.—Switches, circuit breakers, fuses, lightning arresters. (7) CIRCUITS.—Series and parallel; load distribution and voltage calculation; feeders and their calculation. (8) CONSTANTS OF CIRCUITS.—Effective resistance, self-induction and mutual inductance, capacity, three-phase values derived from single-phase, natural frequency. (9) GENERATION.—Prime movers, hydraulic power, steam power, internal combustion engines, A. C. vs. D. C., electrical generators. (10) TRANSMISSION.—Right of way, calculations, problems. (11) DISTRIBUTION.—Center of distribution, regenerators, loads and machines, characteristics. (12) MEASUREMENT AND CONTRACT RATES.—Ammeters, Voltmeters, wattmeters, watthour meters, types and sources of error, curve drawing instruments, curve analysis, calculations, methods of charging for power. (13) LINE PHENOMENA.—Inductance, and capacity, oscillations and surges, wave length. Waves: Standing, traveling, corona.

ALTERNATING CURRENT DESIGN, by Julius Frith. Published by D. Van Nostrand, New York City. 115 pages. Price $2.00.

This work is intended as a companion book to Continuous Current Machine Design by Camp. It is designed and developed from a non-mathematical standpoint, emphasizing physical meaning and imparting ideas as well as information. All parts while brief are particularly clear. The book is divided into fourteen chapters, taking up the following subjects: (1) Alternating Currents; (2) Armature Reaction; (3) Relation of Dimensions to Output; (4) Example of the Design of an Alter-

nator; (5) Synchronous Machinery in Parallel; (6) Compound Wound Alternators; (7) Induction Motors; (8) Design of Induction Motor; (9) Static Transformers; (110) Design of a Transformer; (11) Transmission Lines; (12) Choking Coils; (13) Example of Design of an Alternator; (14) Design of 2-Phase Squirrel Cage Induction Motor and Auto-Starter.

THE ART OF ILLUMINATION, by Louis Bell, Ph. D. Published by McGraw-Hill Book Co., New York City. Second edition, revised and enlarged. 344 pages. Price $2.50.

This work has been so thoroughly revised and enlarged when compared with the first edition that it is practically a new production. Dr. Bell in his preface calls attention to the rapidly changing features of illuminating engineering and the valuable deductions that are now available from the experience of past few years. This is the key note throughout the work, all material both theoretical and practical being brought up to the minute. A work of this nature stamped with the approval of Dr. Louis Bell needs no further recommendation to the electrical engineer of today. His effort in this direction is characteristic of those in others. e are sure we are not falling far short of the mark when we say that this his latest work represents the newest and best in the art of illumination for both practical man and theorist.

The work will be especially valuable to many engineers on account of the large amount of information and data on the lighting of particular interiors, something like seventy-five pages being devoted to this subject. Exterior illumination is treated with equal thoroughness, while the subject of lighting units, shades and reflectors is reduced to the carefullest comparison, replete with curves, data and diagrams. We take pleasure in introducing this work to thost interested in illumination from the standpoint of the engineering involved. In such hands it will be most valuable.

FIVE FIGURE LOGARITHMS, by Henry Harrison Suplee. Published by J. B. Lippincott Co., Philadelphia, Pa. Price $2.00.

This work is undoubtedly the most compact, best arranged and handiest set of tables of logarithms published. Another commendable feature that will appeal to those who use logarithms infrequently, is the introduction giving examples and explaining fully the use of the tables. The volume contains about 100 pages bound in flexible leather, pocket size. We can here say too little in recommending its use for ordinary computations by the electrical engineer.

PERSONALS.

Mr. J. W. FRASER, who for the past seven years has formed the mainspring of the Electrical Department of the Southern Power Company and been responsible for the Electrical Engineering in connection with its many hydro-electric developments, has recently resigned to accept a position with the British Westinghouse Electric & Mfg. Co. Mr. Fraser sailed for England April 15, going to Manchester, England. Later he will have entire charge of a large hydro-electric plant with transmission lines to be constructed in Tasmania by the above company. Mr. Fraser leaves on this side of the water many warm friends who regret his leaving, yet wish him much success and congratulate the company that has been so fortunate as to secure his engineering services. Mr. Fraser's address for a time will be, care John S. Peck, C. E., British Westinghouse Electric and Mfg. Co., Trafford Park, Manchester, England.

MR. ANDREW KENNETH MURRAY, for the past two years Western Manager of the Cotton Publishing Co., publishers of Southern Electrician and Cotton, has resigned to accept a position in another field. The above company regrets the necessity for this change, since Mr. Murry has through his earnest and enthusiastic endeavor made the papers known and the importance of their work felt in his territory. Mr. Murray is the possessor of a magnetic personality and leaves in the West a host of friends including clients and others, who will be glad to know of his advancement and wish him all success. His position in the West will be filled by Mr. W. A. Youngquist.

HARRY B. LOGAN, President of Dossert & Co., was elected an associate of the American Institute of Electrical Engineers at the April meeting of that body.

Mr. OSCAR B. COBLENTZ has been appointed general manager of the Morris Iron Company, of Frederick, Md. Mr. E. P. Morris, vice-president, has been assigned to the New York office at 90 West Street, where he will devote his time and attention to the exploitation of the company's product in New York State, New England and foreign countries. The general sales offices of the company will be located at Frederick, Md., under the management of Eugene Creed as heretofore.

Mr. L. M. WEBB, formerly of the Brilliant Electric Company, has taken a position with the Department of Publicity of the National Electric Lamp Association, Cleveland, Ohio.

Alphabetical Index to Advertisers.

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CONTENTS.

Convention Dialogues and Convention Results.

Time—June 10-14, 1912.

Place—Seattle N. E. L. A. Convention.

Cast—William Uptodate, Mgr., Enterprising Light and Power Co.; Edward Driftalong, Mgr., Deadville Lighting Co.

Billy—"Well, Ed, what are you doing in your section to boost business?"

Ed—"We're fighting the city council to keep from lowering our rate of 18 cents per."

Billy—"For heaven's sake, Ed, are you in the woods yet? If you have come up here for amunition to go back and continue to bluff your customers into an 18-cent rate—well, say, you had better take the next train for home."

Perhaps the exchange of thought in this scene may be a little exaggerated in comparison with the many that anyone can take in if he gets within hearing distance of the small groups that naturally form at this particular convention. Strenuous as the work of the convention has become, and much as everyone may desire to get a rest between times, these groups exist and grow larger in number as conventions roll by, and here is to be found some of the best fruit of the whole gathering. Could it in some way find a place in the proceedings it would be generally so judged. The bouncing of one mind against another in a serious yet informal way has been the order of progress in the past, and in no industry can this be done with more profit than in that which includes central station activity. No two sections present the same conditions, and no two methods exactly alike executed by two different organizations will bring about exactly the same results. Yet the results of one section, when told to the representative of another striving for the same ends, on account of a familiarity with his own conditions, presents a new perspective and a new way out of old troubles.

The meaning of the term convention in connection with the National Electric Light Association has undergone a decided evolution. There are many who can remember, and the others who attend conventions are being constantly reminded that the successes of such were and are now sometimes measured by the amount of pleasure and recreation that can be provided by the holding body. The general aspect of N. E. L. A. conventions has been in the other direction, and now the determining factor is where to find a place large enough to accommodate the crowd that is sure to be present, and further how to arrange a program with the least possible fun in it, assign to all subjects the proper amount of time, crowd all this into a reasonable number of days and satisfy all. When it is realized that over five thousand now attend this convention, whose official positions show that they are men shaping every phase of the electrical industry, certainly no better indication could be secured of the accepted meaning which has become attached to the N. E. L. A. interpretation of the purpose of the gathering.

The increasing importance and amount of time given to commercial subjects has probably done more than any one thing to create this kind of interest in the N. E. L. A. The birth and development of the commercial section and the activity of such men as George Williams, H. G. Gille and Phillip S. Dodd and their line of followers has put new life into central station work. These men recognized the commercial needs of the industry and burst the bubble of commercial enthusiasm to find myriads of smaller ones needing only the breath of an organizer to float them and make them a factor in the work.

Along with the development of commercial activity and the organization of departments to carry on this work in particular territories has grown a deeper activity among public utility executives. The broad gauge, high caliber men in the industry have recognized the dividend-paying possibilities of public good-will, and get a body of these men together and listen for the gist of the discussion and you will learn why public sentiment is the most powerful influence in the utility's relations with a community. A survey of the conditions throughout the central station field during the last year or two shows that there is an actual although gradual improvement generally taking place in as far as relationship between the central station and the public is concerned. This more favorable situation has largely been the result of a recognition that the people are the source of revenue, rights and privileges, and in those places where such an attitude has been plainly evident the largest and most beneficial new business strides result.

In the beginning of these remarks we referred to a conversation over rates. We do not desire to leave the impression that the modern public utility corporation must, in order to increase its business and establish friendly relations with the public, have an exceptionally low rate. The present day demand of the public is a square deal which in central station business, narrowed down to its limits, means a reasonable rate and an efficient service. To explain the term "reasonable" we quote freely from a report by the Railroad Securities Commission to President Taft. "A reasonable return is one which under honest accounting and responsible management will attract the amount of investors' money needed for the development of facilities. Where the investment is secure, the reasonable return is a rate which approximates the rate of interest prevailing in other industries. Where the future is uncertain, the investor demands and is justified in demanding a chance of added profit to compensate for his risk. If rates are going to be reduced whenever dividends exceed current rates of interest, investors will seek other fields where the hazzard is less or the opportunity greater."

The rate problem has been dragged into too many discussions by those incompetent to discuss it logically, and public sentiment is only now recovering from the greedy designs of those of the old school of public utility operators, the unfortunate members to the industry, who were the cause for such discussions and the unfavorable conditions which are fast becoming a thing of the past.

The Hon. George B. Cortelyou, President Consolidated Gas Co., of New York, reduced this matter of return to its lowest terms in an address at Philadelphia in April when he said: "It should be remembered that when franchises were granted to public utility companies they were granted with the idea that a service absolutely essential to the growth of the community was to be provided, and it must be remembered that in many cases those who obtained these privileges or franchises faced a serious risk in making their investment, and there was no assurance that an adequate return would be forthcoming for the money and energy expended in the building up of the service.

"If there is one thing more than another that is a menace to industrial progress, I believe it is the untenable position assumed by some extremists who would limit the return allowed to such corporations as those which are of the public utility class, to a rate so low that it either barely equals the legal rate of interest, or, taking into account the varying factors that must be considered in the case of each company, a rate that is practically but a fraction above confiscation. To induce original investment and development, to insure progress after establishment, to safeguard both the company and the community, a return not merely theoretically but actually fair and liberal must be permitted if the normal laws of trade are still in effect, and we believe that they are."

Give and Take at the Convention.

This is one time in the year when the "big head" over some seemingly striking success can be ably treated, for to find that yours is not the only select spot and yours not the only live organization in the territory operated by over one thousand companies, is a reducer the equal of which has yet to be found. On account of this fact there is little of the braggadocio to be found at the convention meetings. Every member is literally transfigured into a technical and commercial sponge carrying away a tremendous load of potential energy. When first considering an attempt to digest the 60 odd items on the program, there may be a tendency to back out, but a careful study of it reveals that those responsible for its make up had this in mind, and have arranged it as systematically as possible, a perfection of other years' programs.

To the regular followers of the convention few instructions are necessary. To those who are going for the first or second time let us say, by all means study your program and read over the advance papers before going to the sessions! Then get into the discussions and help to make the suggestions and experiences there presented truly country wide. The fund of information which appears in permanent form in the proceedings of the largest engineering and commercial organization in the world is not to be found in anything like the same nature and proportions elsewhere, and all it now lacks is more opinions more widely distributed, which can only come from a participation by all.

Those who do not find it possible to attend this convention, we urge to secure the papers and reports. Read the papers which represent your particular line of activity, and send to the convention a written discussion representing your suggestions and experiences on the topics treated; this will help you by presenting the opportunity for a discussion on points on which you perhaps desire enlightenment. This, as we have said before, you will receive through the reports of the discussions presented in the technical publications, and later in complete and detailed form in the volumes of proceedings. There is no excuse for any member of the N. E. L. A. failing to secure the benefits possible except through ignorance or indifference. For your own good and that of the industry, lend your aid at the convention whether you go or stay at home.

A Birdseye View of the City of Seattle, Washington, Showing Location of Armory and Meeting Place of N. E. L. A. in Convention.

The N. E. L. A. and the Future of the Electric Light and Power Industry.

(*Contributed Exclusively to* Southern Electrician.)

BY JOHN A. RANDOLPH, ELECTRICAL ENGINEER WITH NEW YORK EDISON COMPANY.

IN February 25, 1885, when eighty-seven men assembled in the Grand Pacific Hotel at Chicago to found the National Electric Light Association, the companies engaged in the light and power industry in the various parts of the country were unorganized. There were but few sources to which they could turn for information and, working independently of one another, they were obliged to solve their problems as best they could with little outside assistance. The employees gained their knowledge principally from experience, for other educational facilities for electrical men were decidedly few and incomplete. In order to systematize and preserve the facts gained from practical work note book records of important observations were kept and these books comprised practically the only written references possessed by their owners.

This limited and independent state of affairs was tolerable during the early days of the industry, but as the lighting field gradually broadened and its work became more complex, the prominent lighting men, realizing that far greater results could be accomplished, if the various companies would endeavor to solve collectively the problems constantly arising. They therefore began to advocate the organization of the corporations for mutual assistance and protection, arguing that a systematic general distribution of the results gained from the experiences of the companies at large, in a manner that all might profit therefrom, would be of inestimable value to the individual companies and to the light and power industry as a whole.

Fig. 1. The Seattle Armory and Convention Meeting Place.

It was with this end in view that the National Electric Light Association was formed, and in 27 years enabled it to become the largest and strongest organization of its kind. It required much diligent work, at first, to arouse the interest of the companies for, being a new project, it did not elicit the attention that it has attracted in later years. At the first meeting the number of companies represented was fifty-three. These were enrolled as charter members. The proceedings consisted principally in formulating plans for the future of the organization. Those present were enthusiastic over the purpose of the meeting and at once entered the work diligently.

With the Association fairly launched at the Chicago meeting, its aims became better understood, hence its progress was healthy. At the second meeting six months later in New York, seventy-four companies were represented. The third meeting was held in Baltimore on February 10, 1886. A notable proceeding of this convention was the adoption of a resolution that the N. E. L. A. form a bureau for the collection and distribution of information regarding electric light matters to be under the control of the president and that he employ a secretary and rent a permanent office for the Association. The wisdom of this move soon became apparent in the assistance which it rendered the members and it has ever since proved a most valuable adjunct of the Association.

By this time, the scope of the organization had become clearly defined and the members consequently manifested a great interest in its proceedings. Subjects of deep importance to the light and power industry were assigned to

able men for the writing of papers. These were read at the conventions and discussed by those present. The discussions brought out additional information hence were entered into with great enthusiasm. The industry being new at that period, comparatively little was known concerning its possibilities, therefore the information available through the papers and discussions of the conventions was eagerly sought. The demand for reports of the proceedings became so great both in this country and abroad that, after the third convention, they were printed in proper form and distributed, every member receiving a copy. This procedure has continued to the present day and it is doubtful if a more complete and comprehensive history of the electric lighting development in the United States can anywhere be found than is contained in these volumes. Not only do the results achieved appear therein, but they also give the names of the leading companies and men engaged in the industry during the successive years since the organization was founded.

It early became apparent that the appointing of committees for investigation along various lines, would greatly facilitate and broaden the work. Accordingly, groups of men were appointed for this purpose. They were selected from the most expert in the subjects to which they were alloted. After performing the work assigned them, they gave their reports to the conventions, these reports constituting one of the prominent features of the meetings.

The growth of the N. E. L. A. has been rapid from the start. At the first convention in Chicago, fifty-three companies were represented; at the second in New York, seventy-four companies; at the third in Baltimore, a hundred and two companies; at the fourth in Detroit, a hundred and twenty-four companies, and at the fifth in Philadelphia, a hundred and fifty- nine companies. Considering the fact that these conventions were but six months apart, this continual increase shows a keen interest of the lighting men of that period in the development of the Association. This healthy growth has continued to the present time, until to-day over a thousand companies are enrolled.

In later years, it has been found advantageous to divide the membership into classes. A consideration of these, shows clearly the qualifications necessary for joining the organization. The members now consist of both companies and their employees together with other men of prominence in the electrical field. The divisions and their respective requirements are as follows:

Class A. Comprising private corporations or individuals engaged in the business of producing or supplying electricity for light, heat or power for commercial or public use.

Class B. Comprising officers or employees of Class A member companies elected and continued from year to year with the written consent of the Class A member company with which they are connected.

Class C. Comprising instructors, teachers and practitioners of engineering and related sciences and other professions who are in sympathy with and approve of the objects of the Association.

Class D. Comprising electricians, electrical or mechananical engineers, manufacturers and publishers—corporations or individuals directly or indirectly interested in advancing the use of electricity.

Class E. Comprising officers or employees of Class D member companies elected and continued with the written consent of Class D member company with which they are connected, or they may be other persons interested in advancing the central station industry not employed by a company eligible for membership, porposed and recommended by a Class A member in the territory where the applicant resides.

Honorary members. Comprising gentlemen whose scientific or practical knowledge, efforts and interests in behalf of the electrical industry commend them to the Association.

To further facilitate the work of the organization, geographic sections have been formed. Their territory is bounded by political lines and includes not less than one of the standard sub-divisions of the United States, or a dependency, foreign country, or province of Canada, for example: the Georgia Section, Mississippi Section, and New England Section.

In addition to the geographic sections, local sections have been formed comprising the members in a certain city or in two or more cities that are close together. These are known as Company Sections and their work has been decidedly effective. Meetings are usually held monthly in the larger sections and serve to bind the members more closely together, thus keeping alive their interest in the national body. The two largest of these bodies, at the present writing, are the Commonwealth Edison Company of Chicago with 1763 members and the New York Companies' Section comprising 1618 members connected with nine companies located in New York and vicinity. Other large sections are the Edison Electric Illuminating Company Section of Brooklyn and the Philadelphia Electric Company Section. In addition to these are many others in various localities where the number of members has warranted their formation. The meetings of these sections are devoted principally to papers and addresses upon subjects of local and general interest. The papers are discussed by the members and thus additional information on the subjects is secured. The educational values of these meetings is great, hence they are performing an important service in enlightening the employees of the companies represented. After the business is concluded, entertainment features are introduced which afford ample social diversion.

Another feature in connection with the work of these sections which arouses intense interest consists of contests among the members with prizes for the successful competitors. The main points for which awards are made are generally the best paper written by the members, the amount and merits of the talks given in the discussions, the number of new members secured and the attendance. The prizes are very valuable, hence stimulate the members to great activity. The reward offered in a number of these contests inaugurated during the past year has been a trip to the Seattle convention this month with all necessary expenses paid. A prize given in a contest of papers held by the New York Companies' Section last summer consisted of a trip to Niagara Falls with passes to the power plants there. Three prizes were given, one apiece for the best technical, the best accounting, and the best commercial paper. There is now a standing membership contest in the same section. All members proposing a specified number of new members are given a choice of a long list of publications. These contests have been fairly conducted and have stimulated the members to an extent of activity which they otherwise would not have considered worth while. Men from the rank and file have been particularly enthusiastic and it is a noteworthy fact that to them has gone a large

FIG. 2. THE ELECTRON PLANT OF PUGET SOUND POWER CO., ON PUYALLUP RIVER.

hare of the prizes. The successful competitors have not een the only ones to profit by these contests, for, in the ecuring of data, studying, writing, talking, working in onnection with the various subjects, the men have secured nowledge and experience of incalculable value which they vould not have taken the trouble to acquire without the inspiration of the possibility of winning one of these valuable prizes.

A prominent feature of the Company Section is the bulletin which is published by a number of the larger sections. These publications are published monthly and contain all the electrical news of local interest that can be gathered. They contain personal items, articles written by the members, copies of the papers and addresses presented at the meetings, important notices, cartoons and compositions of a humorous character. These little periodicals are eagerly read by the members and serve to keep all in touch with the proceedings of the section whether they attend or not. To many, these bulletins are of more interest than the daily papers, hence, it is quite common for the daily to be laid aside on the day when the bulletins are issued, out of preference for the latter.

The national body also issues a monthly bulletin. This paper contains the important news of the Association at large, gives the names of all officers and members of committees and such other information as will enable anyone to communicate readily with the proper parties at headquarters for information. However, the most important and popular feature of this publication is the Question Box, over half of the paper being devoted to this department. It is composed of questions by the members upon problems which they have encountered and answers by other members who have either met and solved the problem or know of its solution elsewhere. This department is decidedly popular and the questions with their answers, properly classified and systematized under the able management of a special editor, constitute reading matter both interesting and very instructive. Being based upon practical experience, they are of great value to the men engaged in the various lines in which they are classified.

Another publication which the Association supplies free to its members is "The Electrical Solicitors' Handbook." This consists of a book made of such a size, binding and material as to enable it to be carried constantly in a pocket. As its name implies, it is published for the purpose of supplying information which will be of great assistance to electrical men in dealing with the public. Its contents are grouped under the following headings: "The Elements of Central Station Business Getting;" "Talking Points;" "Illumination;" "Electric Heating;" "Electric Power;" "Electric Vehicles;" and "Units and Electrical Terms." Under these various subjects are published well chosen facts, figures, data, descriptions and explanations on all problems and subjects ordinarily encountered by the electrical solicitor under these headings. The editing of the book is entrusted to a standing committee and its information is secured from the most expert and reliable sources to be found.

A book to be issued in the near future consists of an "Electrical Meterman's Handbook." This will probably be issued free to all Class A members and at publication cost to Class B members. It is being compiled by the Meter Committee and, judging by the excellent work of this committee in the past, is likely to contain the most modern, complete and useful data on the subject to be found.

The main feature of the proceedings of the national convention thus far is the reports of the various committees. The designations of the respective committees are as follows: Public Policy; Library; Finance; Solicitors' Handbook; Exhibition; Commercial Section; Constitution and By-laws; Rate Research; Power Transmission; Membership; Question Box; Question Box Revision; Transportation; Accounting; Prime Movers; Overhead Line Construction; Lamps; Electrical Apparatus; Meters; Terminology; Grounding Secondaries; Underground Construction; Protection from Lightning and Other Static Disturbances; Electrical Measurements and Values; and Street Lighting. The work of some of these is of an executive and general nature, but the majority, as their name implies, are concerned with the making of investigations and the collection of data regarding the subjects assigned them. Their reports are carefully compiled, no time nor expense being spared in their preparation. The men are among the foremost in their lines, hence no more reliable or complete authority on these subjects can be found than these reports. They are printed together with the papers, discussions and other transactions of the convention, the combined proceedings being then issued in the form of neat volumes to the members. As a work of reference, these volumes are of inestimable value to men engaged in the light and power industry.

Of these committees, the most important is that devoted to Public Policy. Their duties consist in dealing with problems which arise between the light and power industry and the public. Companies who have met obstacles in the form of private competition, municipal ownership, adverse legislation, disagreements with employees and other matters in which the policy of the companies is concerned can readily obtain valuable assistance from this committee who stand ready to devote time and talents to this purpose which it would be very difficult to obtain for other interests.

The report of this committee at the last convention in New York together with the address which followed it will

long be remembered by those who heard it. It was devoted entirely to suggestions and recommendations in regard to the relations between companies and their employees. The outline of the report was clearly stated in the beginning in the form of questions. These were as follows: "(a) Are our employees, individually and collectively, receiving all the results of their labor to which they may be properly entitled? (b) Are they properly compensated in the event of industrial sickness or accident? Do we appreciate and fairly assume the responsibility—moral if not technical—sometimes resting upon us to restore an injured employee to health, or in the event of a fatal accident, to provide adequately for his dependents? (c) Do we take sufficient interest in the welfare of our employees when, owing to conditions beyond their control, such as serious sickness, they are in distress and possibly subjected to want and deprivation? (d) Are there any available means other than those now employed by which the efficiency of labor can be fairly increased? (e) Can the differences between labor and capital be lessened or removed without decreasing the efficiency of labor?"

The body of the report enlarging upon these questions was of intense interest and many a man present felt an inward throb of gratitude to the men who had so ably investigated and reported upon this subject. That the work of the committee in this connection has been seriously considered, is shown by the fact that several of the larger companies have already adopted systems of profit sharing and annuities which will be of great value to their employees in the future.

Another important committee is that to which is assigned the subject of rate research. The question of rates is one upon which a great variety of views exists. The various companies throughout the country have their own systems and follow them independently. While the general trend of these systems is uniform, there is a wide difference in details. Local conditions, availability of fuel, cost of power generation and demand for current are chiefly responsible for this, hence it will likely be some time before a system will be produced which can be applied to general use. It would doubtless be to the interest of the light and power industry at large, however, if the various companies could adopt a more uniform scale. This would enable them better to avoid complications with Public Service Commissions. At present, the latter can find a wide difference in rates by conferring with commissions in other localities. A possibility of the future is that, in view of this lack of uniformity and its attendant complications, the commission may cause a system to be put into effect by legislation which all will have to follow. It would be better, however, if the lighting men themselves could agree upon such a system without outside interference. The committee is gathering information upon the subject which will enable the members of the organization to better keep in touch with the practices followed in this particular by other companies. This information is of decided value, hence is eagerly received by the members.

The National Electric Light Association today is the largest of the electrical and engineering associations of the world. Its great membership roll shows its power and influence. At the present writing, May 1, the number of members, by classes, is as follows: Class A, 1,049; Class B, 9,083; Class C, 43; Class D, 234; Class E, 943, making a grand total of 11,352. With its growth continuing at the present rate, it is likely, in a few years, to reach the 25,000 mark. With the rapid development, in recent years, of the company sections, the rank and file of the light and power industry are coming more than ever before, to the realization of the benefits to be derived from membership in this great organization, and are accordingly availing themselves of the privilege.

THE CONVENTION AT SEATTLE.

The thirty-fifth convention which will be held this year on June 10 to 14, at Seattle, promises to be the largest and most far reaching in results of any that have yet been held. This will be the first that has met in the far West, the farthest west of any previous convention having been the 28th, which was held at Denver-Colorado Springs in 1905. These gatherings heretofore have met in the East and Middle West.

The meeting place has been wisely chosen, for Seattle with its population of 280,000, is the largest city in the State of Washington, and is one of the most progressive cities in the United States. It lies in the western part of the state on the east shore of Puget Sound. It has one of the finest deep water harbors in the world and is the headquarters for the lumbering, fishing, mining and agricultural interests of that region. The lumbering industry is enormous, for Washington is the leading state in the manufacture of lumber and shingles; in fact, fully 60% of the shingles used in the United States are cut there. The salmon business of western Washington amounts to $10,000,000 annually. The great agricultural resources of the state are shown in its production annually of 35,000,000 to 40,000,000 bushels of wheat; 10,000,000 bushels of oats; 6,882,000 bushels of barley; and 132,000 bushels of rice.

The convention will be held in the armory, an immense building with a normal seating capacity of 3,500 and with accommodations for 4,000 people, if necessary. Its large drill hall, gymnasium and theatre afford ample room for the parallel sessions which it has been found expedient to hold in order to economize time. The building overlooks Puget Sound and is within convenient distance of the hotels and central portion of the city.

One end of the great drill hall will be set aside for Class D members' exhibition feature. The floor plan for this space provides for seventy booths comprising about 8,000 square feet of floor space. This area will be separated from the other portion of the hall, used as a main assembly room, by a double partition with lobbies and doors intercommunicating with the two halls. This arrangement will afford a ready means of passage from one hall to the other with but very little noise and confusion.

The customary entertainment features will meet the requirements of the most fastidious. For steamer trips, Lake Washington at the east of the city and Puget Sount at the west, with their vast panorama of scenery, offer unparalleled facilities. These trips will afford an excellent view of the majestic Washington forests, the snow-capped Cascades inland to the east and the Olympic mountains to the west. The famous Mt. Rainier at Tacoma, 14,444 feet high, can also be seen. The many excellent roads will offer ample opportunities to visit by automobile the numerous beautiful localities. The region abounds in lakes, streams, mountains, forests and other beautiful points of interest to the sightseer.

ELECTRICAL DEVELOPMENTS ABOUT SEATTLE.

The holding of the convention at Seattle will afford the delegates an excellent opportunity for the study and observation of hydro-electric power generation and transmission. In view of the rapid strides made in this line during recent years, it seems fitting that the Association, which includes this subject in its wide range of activities, should convene in a place where the development and use of mountain water power can be seen and studied at an advantage. In previous years, with the exception of its convention at Niagara Falls, it has met mostly in places where the bulk of the electric power was generated by steam. The convention this year, therefore, held in a great western hydro-electric power center, will furnish, in a sense, an innovation which will attract additional interest. Two of the committees directly concerned in this line of work are the Power Transmission Committee and the Committee on Prime Movers. Their reports are always of great value to the industry and their water power features are likely, at this convention, to arouse more than usual attention because of the locality and the large number of men in this line of business who will be present.

The municipal lighting system of Seattle is supplied by current generated by water power at Cedar Falls on the Cedar River in the Cascade Mountains. The entire watershed of this stream is owned by the city as are also the power plant, transmission lines, sub-stations and the distribution system in the city proper. The dam is of timber and is located at the outlet of Cedar Lake on the Cedar River about forty-four miles from Seattle. Two wooden stave pipe lines carry the water from this dam down through the river bed to the falls three miles distant, where they connect with three steel penstocks leading to the power house. This arrangement gives an effective head of five hundred and fifty feet. The normal rated capacity of the plant is 10,400 kw. made up of two 1,200 kw. generators and two 4,000 kw. generators connected to turbines. The power is carried over transmission lines to the city and there stepped down for consumption.

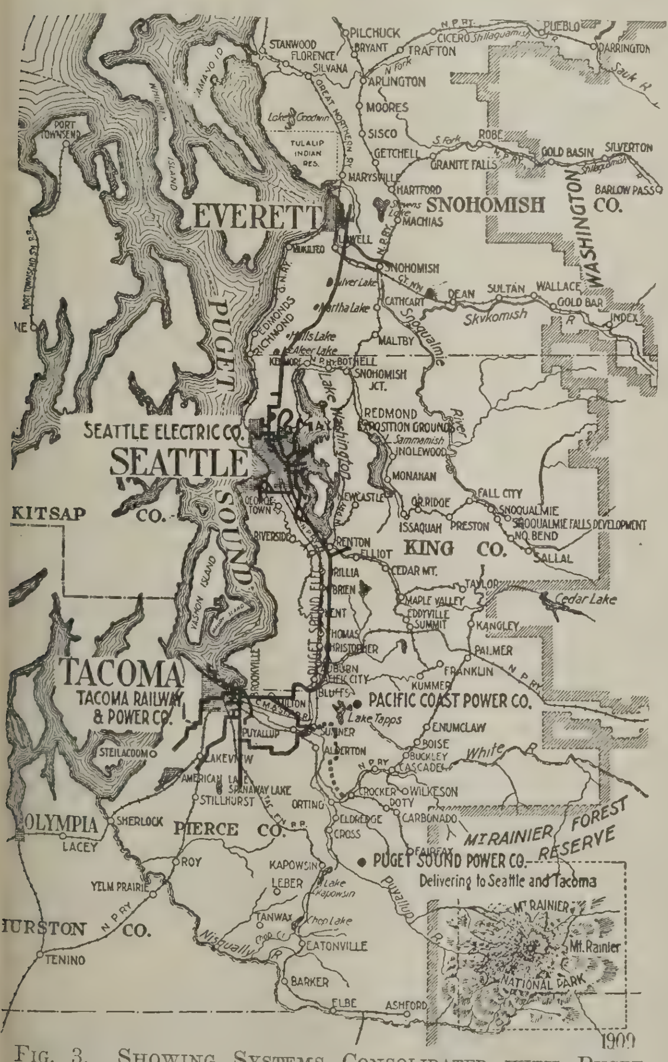


FIG. 3. SHOWING SYSTEMS CONSOLIDATED WITH PUGET SOUND TRACTION, LIGHT AND POWER COMPANY.

While the municipal electric plant at Seattle controls the municipal electrical business, the Seattle Electric Co. has of late practically controlled the street railway business and the largest part of the electric light and power business in the city. This company is managed by the Stone and Webster corporation, of Boston, Mass., and controls the Puget Sound Power Company, a hydro-electric company with plant on Puyallup River at Electron, shown in Fig. 2. The Pacific Coast Power Company with new plant on the White River in turn owns a controlling interest in the Seattle Electric Company mentioned above and the Seattle-Tacoma Power Company, which has a plant at the Suoqualmie Falls.

The system of the company known as the Seattle Electric Company is fed from four steam stations of a total capacity of 23,000 horsepower, and from the hydro-electric development of the Puget Sound Power Company at Electron. The power is distributed through nine sub-stations in various parts of the city. About 190 miles of street railway are operated and 50 square miles is covered by the lighting system in Seattle and suburbs. The subsidiary companies already mentioned, the Puget Sound Power Co., and the Seattle-Everett Traction Company, also serve individual sections. The former company supplies power for distribution to Seattle and Tacoma for railway, lighting and power purposes. The latter company operates an interurban line about 30 miles long from Seattle north to Everett.

It will be seen that the electrical interests in Seattle have been closely related. Recently a consolidation of street railway, light and power companies has been formed which will be known as the Puget Sound Traction, Light and Power Company. This company represents the interests of the leading companies, the Seattle Electric Company, the Seattle-Tacoma Power Company and the Pacific Coast Power Company. The Seattle Electric Company formerly operated a street car system and as already mentioned had a large part of the electric lighting service of Seattle. The Seattle-Tacoma Power Company also operated an electric lighting system, and furnished light to a number of suburban towns. The Pacific Coast Power Company was the owner of the White River development, a large water power plant recently completed on the White River. This development is one of the most comprehensive undertakings on the Pacific coast and the problems which confronted the engineers were extremely interesting as well as complex. The White River is fed by the glaciers of Mt. Ranier and receives its name from the milky silt which the river carries and which gives it a whitish color. The development is about twenty miles east of Tacoma, Wash., the diversion dam being built at a point near the big viaduct

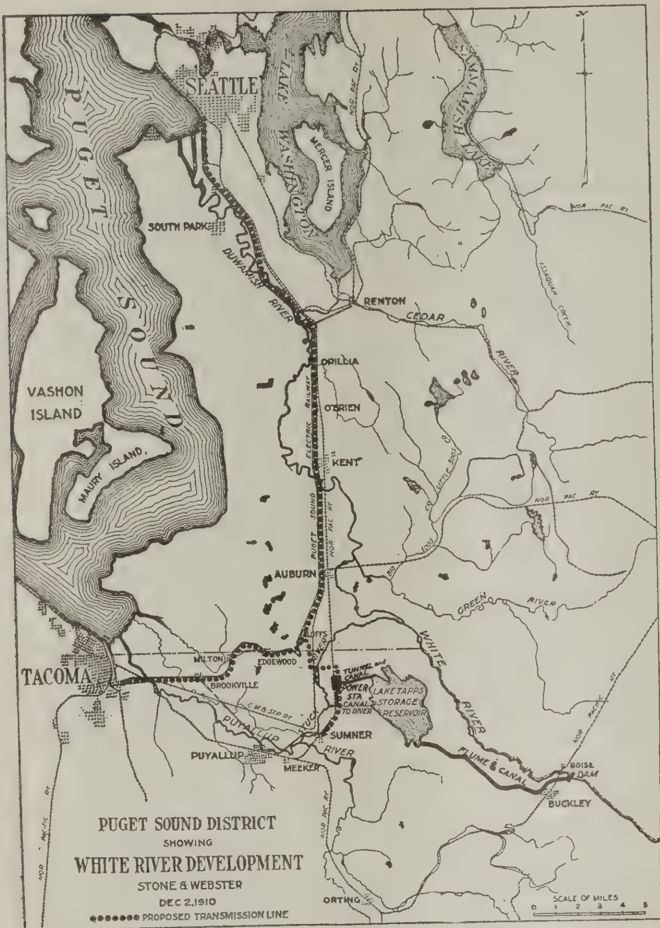


FIG. 4. SHOWING WHITE RIVER DEVELOPMENT OF PACIFIC COAST POWER COMPANY.

of the Northern Pacific railroad, north of Buckley. This is not of unusual size or strength and simply serves to divert the water into a ditch discharging into a settling pond in which the silt will have a chance to be dropped. From the head basin a separate steel pipe line is built for each turbine. These lines are approximately 2,200 feet long, 8 feet in diameter at the upper end and 6 feet in diameter at the power house end.

The power house is designed for six units of 15,000 K.W. capacity, although only two are installed at present. At the time the hydraulic equipment was installed, the turbines were the largest ever built, having a maximum capacity of 20,400 horsepower and operating under a head of 480 feet. These turbines are of Allis-Chalmers design.

The Pacific Coast Power Company, which owned the controlling interest in the Seattle Power Company, besides its plant on the White River already referred to, controlled valable water rights on the white River between Seattle and Tacoma. The newly formed organization, the Puget Sound Traction, Light and Power Company, through absorption of all these companies, will supply electrical energy to the cities of Seattle, Tacoma, and Everett and in the valleys and towns on Puget Sound, being one of the largest interconnected organizations on the Pacific Coast.

This convention promises to be the most far-reaching and effective in results of any of the national gatherings ever held. With over 11,000 members concerned in its proceedings, the information supplied by the papers, reports and discussions will be widely distributed and used to advantage. As the membership increases from year to year, the organization becomes more powerful and efficient. The publishing of the proceédings now requires two large volumes. It is doubtful whether any more complete, comprehensive and practical books upon subjects connected with the light and power industry could be compiled. The contents, written by the most expert men in their respective lines, are based upon practical experience and are thoroughly modern. That the high value of the work of the N. E. L. A. is now generally recognized is apparent from the constant healthy increase in membership. Its efficiency and influence will continue to expand with its growth. It is an invaluable help to the industry and the benefits derived by the members are inestimable.

Acknowledgment is hereby made to the Publicity Bureau of the New Seattle Chamber of Commerce and the Seattle Electric Company for courtesy in furnishing the photographs used for illustrations in this article.

Value of Weston Normal Cell.

A report to the International Committee on Electrical Units and Standards by a special technical committee appointed to investigate and report on the concrete standards of the international electrical units and to recommend a value for the Weston Normal Cell has been prepared under the supervision of Dr. S. W. Stratton, Director of the Bureau of Standards, Department of Commerce and Labor. The International Technical Committee assembled at Washington under the presidency of Dr. Stratton, who is also treasurer of the International Committee. It conducted experimental work at the Bureau of Standards for a period of two months, and carefully considered the results. The conclusions and recommendations are contained in the following resolutions:

(1). The committee decides to choose as the value of the Weston Normal Cell the mean value of the cells presented by the delegates of the four laboratories. This mean was determined in the following way: There was first determined the mean value of the normal cells presented by each delegate, then the mean was taken of the four numbers thus found.

(2). The committee decides to choose, for the present and until there are other mercury ohms prepared, as the value of the international ohm, to be recommended to all countries for general use, the mean of the values of the units realized at the Physikalisch-Technische Reichsanstalt and at the National Physical Laboratory. Although the international ohm as defined by the London Conference has not yet been strictly realized, the Committee believes that its value has been attained in two laboratories independently with a good degree of precision, and that future work is not likely to change it by more than 2 or 3 parts in 100,000.

(3). In view of the fact that the mean of the results with the silver volt-ameter obtained by this committee will probably not be changed by more than a few parts in 100,000, when the specifications are finally completed, the committee decides to recommend to the International Committee on Electrical Units and Standards the following value for the electromotive force of the Weston Normal Cell:

$E = 1.0183$ international volts at 20°C.

On the subject of the standard cells, the committee is of the opinion that new experiments are necessary before completing or changing the specifications of the London Conference.

Instrument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY E. P. PECK, ASST. ELECTRICAL ENGINEER, GEORGIA RAILWAY AND POWER CO.

A Discussion of Motor Tests.

THE motor tests that the testing department of a central station are called on to make are usually those to find out the load required to drive machines to which the motor is connected, or to find out whether or not the motor is overloaded. Tests are some times necessary to locate troubles in the motor and its connections. Many of the tests are not motor tests primarily, but the electrical end of the motor is the most convenient place to measure the power required to drive any machine connected to it. In shops and factories some motors are often overloaded and some underloaded. Electrical tests offer the only satisfactory method of determining these conditions, and they frequently show that the motors may be shifted to other machines, or the load may be shifted from one motor to another, thus equalizing the load and reducing the cost for current.

Tests to determine the characteristics of motors are not ordinarily made by central stations, therefore these tests and efficiency tests will not be taken up.

A load test on a direct current motor is made with an ammeter and voltmeter. To determine the proper size ammeter to use on the test, multiply the horsepower of the motor by the amperes per horsepower. The amperes per horsepower will vary with the voltage, size, efficiency and load of the motor, but for the above purpose the following amperes per horsepower may be used:

Direct Current		A. C.—Single Phase		A. C.—Three Phase	
Volts.	A. per H.P.	Volts	A. per H.P.	Volts	A. per H.P.
110	8	110	10	110	5
220	4	220	5	220	2.5
550	1.5	440	2.5	440	1.25

Thus a 10 Hp., 220 volt d. c. motor would take approximately 40 amperes, and a 50 ampere shunt would be used on the ammeter. A 10 Hp., 220 volt three-phase motor would take approximately 25 amperes, and the current transformer supplying the standard meters would probably be wound for 50 amperes. The power delivered by the motor is less than the input measured on the meters, the difference being the losses in the motor at that load. Motor efficiency varies with the size of motor and the load on it, and is different for different types of motors.

The tables given below are taken from the motor guarantees made by one of the large motor manufacturers. The table of efficiencies applies particularly to standard speed three-phase induction motors, but it is also approximately correct for similar sizes of direct current motors.

The power input to a d. c. motor is usually given in horsepower and equals volts $\times$ amps. $\div$ 746. The output is input times per cent efficiency. The input to an a. c. motor is measured on a wattmeter, but volt and ampere measurements are also taken to get the power factor. The power factor is equal to watts $\div$ volts $\times$ amperes in a single phase circuit; and in a three phase circuit the power factor is equal to watts $\div$ volts $\times$ amperes $\times$ 1.732.

TABLE OF THREE-PHASE MOTOR EFFICIENCIES.

Size of motor. H.P.	Speed. R.P.M.	Efficiency at Full Load. Per cent.
1	1800	79
2	1800	83
3	1800	85
5	1800	86
7.5	1800	88
10	1800	89
15	1200	88
20	1200	88
25	1200	89
35	900	89
50	900	90
75	900	90
100	720	90
150	720	91
200	720	91

TABLE OF THREE-PHASE MOTOR POWER FACTORS.

Size of Motor	Power Factor of Motor.			
H.P.	½ Load.	¾ Load.	Full Load	1¼ Load.
1	.49	.62	.71	.78
2	.63	.76	.83	.87
5	.73	.84	.89	.91
7.5	.75	.86	.90	.92
35	.78	.86	.89	.90
200	.76	.85	.89	.90

Motors of all sizes from a fan motor to a several hundred horsepower motor are connected to central station lines and the testing department is liable to be called to test any of them on short notice. Several tests of different size motors, say a 5 Hp., a 25 Hp. and a 50 Hp. motor, may be made in one mill on one order. The most practical equipment for this work is given in the section on Portable Instruments; namely, a voltmeter and a millivoltmeter with several shunts for direct current tests and a voltmeter, an ammeter, a wattmeter and star box, and a variable ratio current transformer, for alternating current motor tests.

The alternating current motor tests require more work and calculations than direct current motor tests, and the method of using the variable ratio current transformer and star box may not be entirely plain. The following example will show in detail the calculations and connections for such a test.

A ten horsepower 220-volt, three-phase a. c. motor is to be tested to find out if other machinery, requiring two horsepower to operate, may be added to its load without overloading it. The test will be made with the meters mentioned above, and connections made as shown in Fig. 1.

From the table of amps. per Hp., 2.5 is found to be the constant for this motor. Then $2.5 \times 10 = 25$ amps. approximately full load current, and the meters must be of sufficient capacity to carry this without damage to them. The starting current on the motor is not required and the current transformer will be short circuited until the motor is up to speed, as otherwise the heavy current rush would damage the ammeter. It is not known whether the motor is overloaded or underloaded, but to be safe it is best to allow in the instruments for a 50 per cent overload, or for

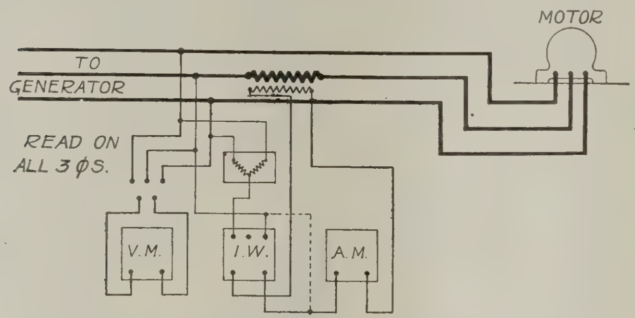


FIG. 1. CONNECTIONS FOR THREE-PHASE MOTOR TEST USING ONE WATTMETER, CURRENT TRANSFORMER AND STAR BOX.

37.5 amps. If the "through type" current transformer used has a ratio of 500 to 5 with one turn, it will have a ratio of 50 to 5 with 10 turns. The transformer is wound with 10 turns, through the hole, of No. 8 B. & S. gauge wire. This will carry the full calculated load, and will give the ammeter and wattmeter a capacity of 50 amperes, which is well on the safe side.

With the connections in Fig. 1, the line watts will be 3 x 10 x wattmeter reading, and the line amperes will be 10 x ammeter reading. With the star box connection the wattmeter reads watts in one phase and the constant 3 is necessary to convert the reading to total watts. The current transformer ratio has been made 10 to 1, hence the constant 10.

After connecting the meters, start the motor and remove the short circuit on the current transformer. The indicating wattmeter is found to read 200, the voltmeter 220, and the ammeter 1.84.

The input to the motor is $3 \times 10 \times 200 = 6000$ watts.

The line amps. are $10 \times 1.84 = 18.4$.

The power factor is $6000 \div 220 \times 18.4 \times 1.732 = 86\%$.

The horsepower input is $6000 \div 746 = 8.05$.

The efficiency of the motor at this load is very close to 88%, hence the horsepower output is $8.05 \times .88 = 7.08$ Hp. Thus from the results of the test it is evident that an additional load of 2 Hp. may be safely added.

Should it be desired to test a three-phase motor with two single-phase wattmeters, connections would be made as shown in Fig. 2. If the voltages and current are not balanced in the three-phases, this method is more accurate than the preceding one, as true watts are measured when two wattmeters are used, regardless of load conditions, while in the star box test an error is introduced by unbalanced loads in the three phases. When two meters are used the sum of the wattmeter readings is the true watts, if the power factor is above 50 per cent, and the difference between the readings is true watts if the power factor is below 50 per cent. When current transformers are used each wattmeter reading must be multiplied by the current transformer ratio, obtained as shown above, before the sum or difference is taken.

It is often difficult to tell when the two wattmeters are properly connected and when the power factor is above 50 per cent. When an induction motor is running with no load the power factor is below 50 per cent, and one meter should read backwards. As load is put on the motor the reversed meter should approach zero, reaching zero when the power factor is 50 per cent, and then read in a positive direction as the load and power factor are increased. It

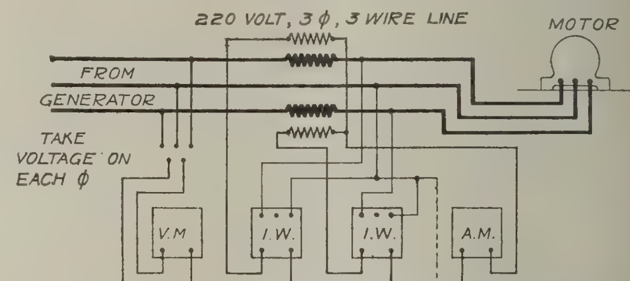


FIG. 2. CONNECTIONS FOR THREE-PHASE MOTOR TEST USING TWO WATTMETERS AND TWO CURRENT TRANSFORMERS.

is a characteristic of an induction motor that the power factor increases as load is increased.

If it is not convenient to change the load, and there is an uncertainty as to whether the wattmeters are properly connected the following check may be used. The meters are connected as shown in Fig. 3. Disconnect the lead of wattmeter No. 1, which connects to leg B and connect it to leg C. If the wattmeter reverses, the power factor is below 50 per cent. Therefore when connected according to Fig. 3, one of the meters should read backwards.

It will be necessary to reverse this meter and consider its readings negative. If there is any power being used the reversed meter must read lower than the meter reading positive. In all of the diagrams care has been taken to show the connections that will give positive readings if the power factor is above 50 per cent for one type of meter.

The proper connections to make a meter read in a positive direction on a single-phase circuit should be made, and current and voltage posts to connect to the same polarities should be marked. For the purpose of connecting meters properly a three-phase circuit may be considered as two direct current circuits with lines A & B, as shown in Fig. 3, positive and line C a negative common return. The arrows then show the direction of current from post to post in the meters. When the polarity test has been made on a single-

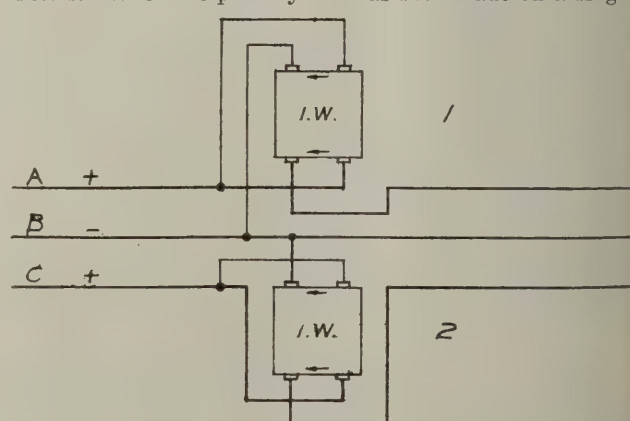


FIG. 3. DIAGRAM SHOWING INSTANTANEOUS POLARITIES OF THREE-PHASE A. C. CIRCUITS.

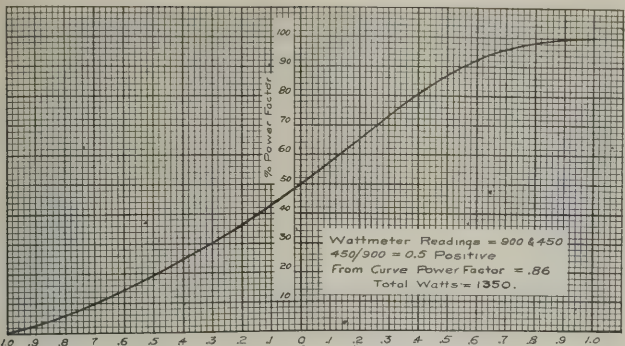


FIG. 4. POWER FACTOR CURVE FOR TWO WATTMETER READINGS ON THREE-PHASE CIRCUIT.

phase circuit it is easy to always connect meters properly on a three-phase circuit.

The curve in Fig. 4 offers a very convenient method of determining the power factor of a balanced three-phase circuit from the two wattmeter readings, or from the readings of one wattmeter with the potential leads connected as No. 1, Fig. 3, for one reading, and the potential lead which is connected to B shifted to C for the other reading. The smaller reading is divided by the larger reading and a decimal factor obtained. If both meters are reading forwards, the factor is positive, and if one meter is reading reversed, the factor is negative. The factor is laid off on the line "Ratio of Readings." From this point follow vertically to the curve and from the curve horizontally to the line graduated in power factors.

The tester is cautioned to look out for stray field errors when making motor tests. The meters should be placed several feet away from the motor, and not near the motor feeders. The effect of the stray field may be seen by connecting the potential coil of the wattmeter to the line—leaving the current posts disconnected. A reading of the wattmeter shows the presence of stray fields and the meters should be moved to a location where the wattmeter will not read with the potential coil alone connected. When using direct current meters, the meters should be placed so that readings, taken with the meters in one position and then turned 180 degrees, are the same. Any difference in the readings, if the voltage and load are constant, shows the presence of stray fields.

The motor troubles encountered are usually produced by very simple causes. The motor may be overloaded, the brushes may be off neutral on a direct current machine, a fuse may be blown in either the starting or running connections to an alternating current motor, there may be trouble in the starting apparatus, etc. The tester should endeavor to find out just what the trouble is and what caused it, but he generally goes no farther than this—turning any necessary repairs over to a repair shop. The methods of locating the multitudinous troubles which may occur in motors is beyond the scope of this series and the reader is referred to several excellent books on this subject.

A Review of Railless Electric Traction in England.

(Contributed Exclusively to SOUTHERN ELECTRICIAN.)

BY R. E. NEALE, A. C. G. I., B. SC.

THE first trackless trolley systems in England were inaugurated in June, 1911, in the neighboring cities of Leeds and Bradford. Since then, these installations have been in continuous satisfactory operation and have been the attraction of innumerable deputations from other towns proposing to lay down similar equipments. The popularity of trackless traction has developed rapidly and there are now over 30 localities seriously considering the installation of trolley busses while systems, similar to those in Leeds and Bradford, will soon be in operation in Rotherham and Dundee. As in most new lines of development, wild enthusiasm and blind prejudice are found side by side, however, it is the moderate view of the possibilities of the system which is most justified.

The general features of the trolley bus are too well known to need repetition here. The vehicle has been aptly described as a cross between a tram car and a petrol bus. It possesses the hight starting torque and overload capacity of the former with the low capital cost and flexibility in use of the latter. The overhead trolley wires are quite unobtrusive, the busses themselves are very handsome, and their traffic dodging capacities are surprising. Curves of 14 feet radius are easily made by trolley busses and the system as a whole is readily adapted to special circumstances such as are encountered at bridges, level crossings and so on. If freight busses are run on the same route as passenger cars, it is an easy matter to arrange for the faster vehicles to pass the slower at any time or place. There has been considerable discussion as to the extent of road damage likely to be effected by trolley busses and as to the basis and means of levying indemnity. So far, it appears that the wear and tear on roads is, if anything, less than that produced by petrol while the saturation of the road surface with grease and oil, at regular stopping places, is entirely avoided in the electrical system.

The low capital cost of the trolley bus which is taken later enables the profitable operation of routes on which only low traffic density can be secured. The tractive resistance of a trolley bus is of the same order as that of a petrol bus and is much higher than that of tramcars, also, repairs and depreciation (pro rata) are much heavier than in the latter so that, in no case are trolley busses to be regarded as substitutes for tramways, where the latter are laid down on a sound financial basis, but merely as the best available means of securing low operating costs, when the revenue is necessarily low, and of profitably developing the traffic of a district. The most obvious fields of applicability of trolley busses are, therefore: (1) In towns with insufficient traffic to warrant the heavier capital cost of a tramway system and in seaside resorts and other places where erratic seasonal traffic is encountered. (2) As "feeders" to existing tramway and railway routes. (3) In city streets

where the rigid route required by tramcars cannot be tolerated. This case covers many London streets and it is probable that numbers of trolley busses will be used in the metropolis before long. (4) In rural and interurban schemes, then in conjunction with the transport of farm produce and the supply of energy for power and lighting to houses and communities en route; in this direction, however, it is easy to let fancy outstrip reason as limited by the present conditions of electrical generation and distribution.

THE ENGLISH SYSTEM OF RAILLESS TRACTION.

The system of railless traction which has hitherto received exclusive application in this country, and which is gaining considerable favor abroad, is that patented by the Railless Electric Traction Co. (R. E. T.) of London. The salient features of the equipment are its simplicity and the use of standard trolley-tram overhead wires and standard trolley collector booms. These advantages are very real for they ensure satisfactory operation of the busses themselves, and enable inter-running from tram to bus routes while reducing to a minimum the cost of conversion of the latter to tramway working.

R. E. T. busses which are now in use in Leeds and Bradford are shown in the photos herewith. Fig. 1 shows the general appearance of the Leeds vehicles and Figs. 2 and 3 illustrate those in use in Bradford. The chief distinction between the two types is that the Bradford cars have a rear entrance while the Leeds busses are entered from the driver's cab. The Leeds vehicles are certainly of better appearance and are cosier to ride in; the driver can collect fares, in case of need, thus dispensing with the conductor. Various other designs have been evolved including a two-compartment bus with two entrances, and a double-deck vehicle. For use in the Far East, single deck busses are being supplied with open-sided trailer cars. The seating capacity of various types is: Single deck, front entry 16 to 28; single deck, rear entry, 20 to 30; single deck, composite, 24 to 32; single deck and trailer, 12 to 20 and 20 to 35; double deck, 36 to 48. Five ton freight busses with take-down sides and special vehicles for various classes of transport are also available.

THE ELECTRICAL EQUIPMENT.

The electrical equipment of the vehicles used at Leeds and Bradford comprises 2-20 h. p., 525 volts, 1,050 r. p. m. commutating pole traction motors driving the rear wheels through a 10:1 reduction provided by oil-immersed worm

FIG. 1. TYPE OF BUS USED AT LEEDS, ENGLAND, SHOWING SWIVEL TROLLEY, MOTOR AND GEARING ARRANGEMENTS.

FIG. 2. TYPE OF BUS USED IN BRADFORD, ENGLAND, SHOWING TROLLEY WIRE SUSPENSION AND EASE IN PASSING VEHICLES.

gearing and a roller chain drive. A series-parallel controller has 9 current positions, 5 running, on the main barrel and 6 on the reversing barrel. Either motor can be cut out at will without removing the controller cover. The speed control provided is much finer and smoother than that on any petrol bus. As shown in Figs. 1 to 3, the trolley boom is of the usual tramway pattern except that in the Leeds vehicles a new typê of swivel trolley head, shown in Fig. 4, has lately been introduced. The trolley wheel swivel pin runs on ball bearings and, being hollow, carries a tail spindle terminating in a ring as shown. The object of this is to facilitate the placing of the trolley wheels on the overhead wires as shown in Fig. 1. In Bradford the booms are controlled by ropes brought down to the conductor's platform. If slack is left in these ropes, they become a menace to passing traffic when the bus runs to one side of the overhead lines, this danger is realized from Fig. 2.

Standard trolley wire is used to supply current, the spacing adopted in Leeds is 13.5 inches between positive and negative and 9 inches between positive and positive, unless wider pitch is required for the accommodation of frogs and cross-overs. Fig. 5 represents an interesting cross-over

FIG. 3. THE BRADFORD BUS, SHOWING REAR ENTRANCE, MOTOR AND GEARING AND OVERHEAD CONSTRUCTION AT TURNING LOOP.

near the centre of Leeds. The central pair of positive wires serve trolley trams and, in conjunction with the outer wires, also supply trolley busses. One pair of the trolley bus lines crosses to a side street as shown and, at the various crossings and junction points, standard cross-overs and frogs are employed but, where insulation is required, as at A A, their ends are built-up on the section insulator principle and length of fibres fill the line gaps.

The Bradford trackless route is about 1.25 miles in length and cross-connects tram routes radiating from the city. It is fed from the tramway feeders at each end and a maximum drop of 4 volts has been observed in each trolley section. The Leeds route is 4 miles in length and the final three miles are fed from the point at which the route

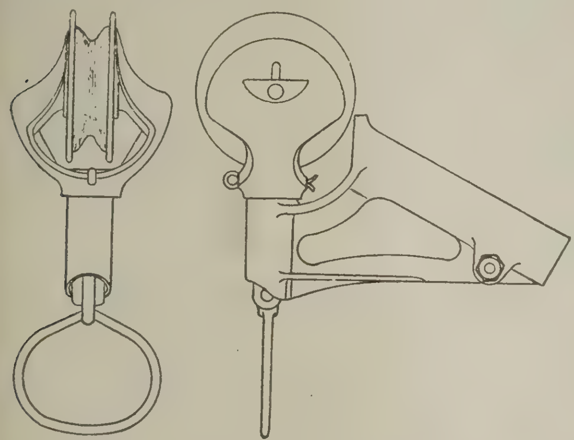


Fig. 4. Type of Swivel Trolley Head Used on Leeds Buses.

leaves the tramway. With two busses running 30-40 volts drop occurs in this 3 miles of trolley route, hence a negative feeder is being run near the far end of the latter from an adjacent tramway. To enable their busses to run over any trolley tram route, the R. E. T. Co. provide pivoted return-current skate booms beneath their vehicles. The rail skate, as seen in Fig. 6, consists essentially of a rail scraper and brush, a guide wheel and a 20-lb. copper contact block. Its construction has proved satisfactory except that the skate is rather liable to jump the rails and to follow the wrong track at points. To overcome these defects, while securing a lighter and cheaper design, the Leeds Corporation is adopting the bogie-collector shown in Fig. 7. To expedite the handling of the busses in depots, the Leeds Tramway Department uses a portable, return-current rail contactor wheel carried by an insulated handle and connected through 7/16 inch flexible cable to a plug socket on the rear of the bus frame. This socket is connected to the

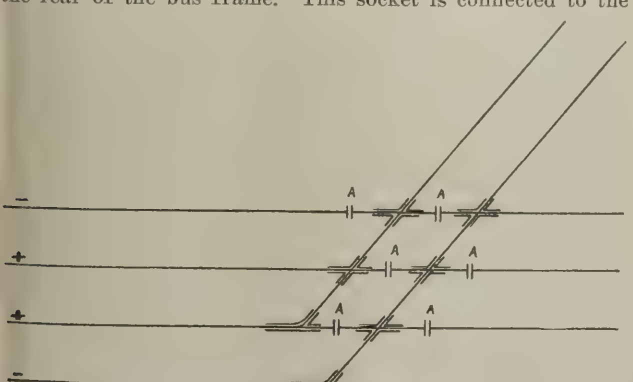


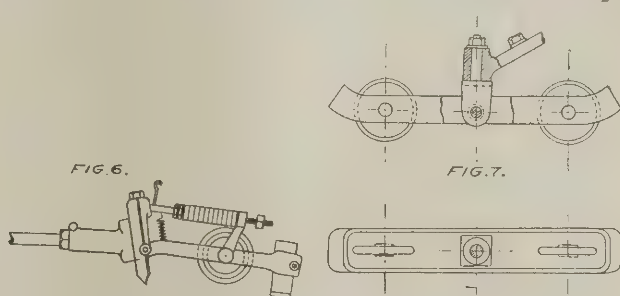
Fig. 5. A Type of Cross-Over Construction at Leeds.

head of the skate boom and when the portable contactor is in use, the skate boom is raised and the negative trolley boom hooked down.

SMOOTHNESS OF RUNNING, SAFETY, BREAKDOWN.

As regards smoothness of running, the writer has found trolley busses to compare favorably with the best petrol busses, while the high frequency vibration due to the engine of the latter is, of course, absent. In Leeds, semi-elliptical plate springs carry the bus body, but in Bradford lever spring "shock absorbers" have been adopted. The busses at present in use exceed the statutory weight limits, but in future, no difficulty is anticipated in bringing the weight of the vehicles down to 4.0 or 4.25 tons.

The wide wheel base, low centre of gravity and twin back tires of the R. E. T. busses make side-slips practically impossible. The most serious accident which has yet been recorded with these vehicles occurred recently at Bradford, when a trolley wheel jumped its wire and the bus, making a sudden swerve, crashed through a wall. Other breakdowns have been limited to twisted worm shafts, broken chains and broken steering rod pins, all troubles which are easily preventeed by amending the original proportions of design.



Figs. 6 and 7. Rail Skates Used When Bus is Run Over Any Trolley System Route.

The first busses supplied were undertired (4.5 inches and 8.5 inches). The insulation resistance of the Leeds and Bradford busses is tested daily and there have been no complaints of shocks received from the bus frame. The insulation resistance of the Leeds vehicles is usually 2 megohms in dry weather, falling to 500,000 ohms in wet weather; the minimum with which vehicles are allowed to remain in service is 250,000 ohms, corresponding to 2 (milliamps) leakage at 500 volts.

THE COST OF SYSTEM.

R. E. T. busses cost $3500 apiece and the overall cost of the necessary street equipment averaged $8,670 per mile in Bradford and $6,220 per mile in Leeds (6,000-$10,000 per mile may be regarded as the limiting extremes). The trackless system avoids the heavy track costs of tramway installations but will often be assessed for road improvements which should have been effected long ago. A capital charge of 5% usually averages 0.75 cents per car mile in the R. E. T. system. The current consumption of the vehicles illustrated in Figs. 1-3 ranges from 0.85 to 1.00 kw. hr. per car mile; tire maintenance is contracted for at 3.0 cents per mile and the total operating costs, including capital and depreciation charges, vary from 11.0 to 13.0 cents per bus-mile, while the revenue varies from 12.0 to 17.0 cents per mile. The Bradford fare is 2 cents for 1.25 miles but, in Leeds, only 4 cents is charged for a 4-mile journey. In the latter city, the operating costs and revenue are very closely balanced. Whereas 2 cents per passenger mile is required by petrol busses, from 1.0 to 1.5 cents per passenger-mile is

profitable to trolley vehicles. There seems no reason to doubt that from 2 to 4 cents per bus mile net profit can generally be realized. This is satisfactory in the classes of service to which trolley busses are best suited. A passenger service is often very desirable though there is no immediate prospect of remunerative traffic and, to meet such cases, several towns are proposing to install trolley busses.

The subjoined table refers to a few towns in which important trackless schemes are now on foot. Most of the schemes pending are due to local authorities but a few are supported by private companies and, in at least one case, works owners along the proposed route are lending financial aid to the scheme. The total expenditure involved by proposals which are likely to be acted upon in the near future amounts to between 3.5 and 5 million dollars. At present railless traction is in the same legal position, (officially,) as ordinary tramways, but there is no means of preventing a company from spanning trolley wires over a roadway so long as the elementary requirements of safety are satisfied, and the supporting poles or brackets and the power feeders are placed on private property with the owner's consent. This fact may be of great practical importance in overcoming wilful opposition to a trackless scheme at parts of a proposed route.

In many cases, the system will yield profitable results where no other form of traction could pay its way but it is obviously absurd to expect it to wring profits from such sterile districts as have been proposed by indiscriminative devotees. Further, I doubt whether trackless traction should be adopted on those routes where a remunerative traffic for trolley trams is assured in the near future. In such cases, it seems better to install the tramway at once, recouping temporary losses from subsequent profits and the lower energy and repairs charges incurred. It was recently proposed to lay down a trackless bus route from Doncaster to a neighboring colliery village but, after considerable opposition, the Borough Engineer succeeded in convincing his committee that a trolley tram route laid on concrete sleepers sunk in the grass by the roadside was the most economical scheme and there are assuredly many other instances to which similar conclusion would apply.

Table 1. Data on Operation of Railless System.

TOWN	Population	Equivalent Mls. Single Tram Track	Car Miles per Annum	Passengers Carried	Average Fare per Passenger	Units per Car Mile	Cost of Energy (cts per kw. hr.)	Total Operating‡ Cost per Car Mile	% Costs to Revenue	Tramway Schedule Speed		Maximum Gradient		Present Trackless Proposals		
										Mean m. p. h	Maxm. m. p. h	Trams	Trolley Busses	Mls. of Route	Service (Mins.)	Total Outlay Involved.
				millions	cts.	kw. hrs.	cts.	cts.	%							
Aberdeen	163000	27.7	1,585,000	17¼	1.96	1.18	2.36	12.24	57	8	14	1–13	-------	1.25	30	$ 15,250
Bradford	288500	100.5	5,461,600	53	2.32	1.87	2.00	14.66	64	7¼	16	1–9.7	1–15	12	15–30	125,000
Brighton & Hove	160500	17.25	1,126,700	10¾	2.20	1.79	2.40	16.04	74	6½	12	1–10	-------	-------	-------	537,500
Edinburgh	320000	1.5	No	returns	yet		2.50	------	------	12	16	1–21	-------	18¼	15–30	175,000
Leeds	477100	108	8,308,500	80¾	2.16	1.72	0.72*	11.28	53	7¼	9–16	1–8.4	1–20	4	20–60	40,000
Rotherham	62600	12	722,400	7	2.30	1.85	3.00	15.58	70	5¾	12	1–10	1–13.9	5†	30	50,000†
West Brom.	68500	12.5		No retur	ns		2.00	------	------	------	------	1–17	-------	27	15	380,000‡

*Works cost. †If the first routes prove remunerative much more ambitious plans will be set on foot.
‡As against $1,655,000 required to provide trolley trams on the same routes.

High Frequency Phenomena with Especial Reference to Oscillations and Surges.

(*Contributed Exclusively to* Southern Electrician.)

BY PROF. W. T. RYAN, IN CHARGE OF COURSES IN CENTRAL STATION TOPICS AND TRANSMISSION DESIGN, UNIVERSITY OF MINNESOTA.

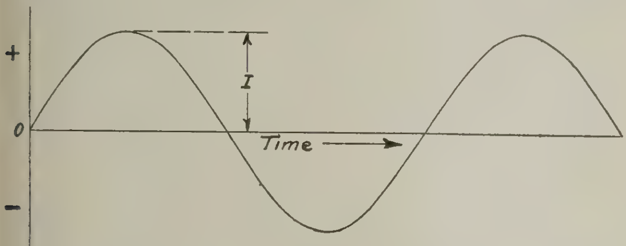
A Practical Treatment of High Frequency Phenomena and Explanation of Destructive Effects on Particular Occasions.

THE object of the writer in this article is to give a short physical treatment of the production and theory of high frequency current with special reference to oscillations and surges. Only simple mathematics will be used and abstruse reasoning avoided, for I do not intend to present or defend any theory but to give you as clear a mental picture as possible of what actually takes place. Wireless telegraphy and telephony as it is practiced today is based on the fact that high frequency current apparatus when suitably proportioned, becomes the source of electromagnetic waves which radiate through space like light waves, and which have the power of producing high frequency currents in the apparatus on which they impinge. A discussion of wireless telegraphy and telephony which, of course, are the chief industrial uses of high frequency currents, will not be attempted here. However, I would like to call your attention to the fact that wireless telephony is now as far advanced as wireless telegraphy was fifteen years ago, and that wireless telephone messages have been successful for distances of over 300 miles. I have no hesitancy in saying that I believe that it is only a matter of two or three generations when telegraph and telephone

poles, wires, underground cables, etc., will only be found in museums.

The oscillations and surges due to lightning and various other kindred high frequency phenomena in electric systems is now of great importance in the electrical profession. Where hundreds of miles of extra high potential wires are inter-connected with underground cables, the possibility of the production of high frequency currents and the destructive capabilities which they possess require the most careful study. The alternating current we use to light our homes and set in motion the wheels of industry starts in at a zero value, rises to a maximum, comes back to zero, then goes to a maximum in the opposite direction, and finally reaches zero again. The complete set of positive and negative values it passes through as time elapses is called a cycle. Ordinary alternating current passes through from 25 to 60 of these sets of values every second, which action may be compared to the swinging of a pendulum.

Suppose two conductors to be connected by a wire, for example, the two plates of a condenser. If they are not at



F. 1. An Alternating Current Curve.

the same potential the electrical equilibrium will be disturbed, just as the mechanical equilibrium is disturbed when a pendulum is displaced from the vertical. In either case there will be a tendency to re-establish this equilibrium. A current will flow through the wire in an effort to equalize the potentials of the two conductors, just as the pendulum swings toward the vertical. But the pendulum will not stop in the position of equilibrium; having acquired a certain velocity, its inertia will carry it beyond this postion. Similarly when our condenser is discharged, the self-induction of the circuit will carry it beyond the point of equilibrium, then it will swing back just as the pendulum does, finally dying out, just as the pendulum finally comes to rest.

If the wire had resistance only and no self-induction, the current would go down to zero and stop. Similarly, if the pendulum were swinging in syrup, for example, it would simply come down to the position of equilibrium and stop. Thus, if a condenser be discharged through a circuit which has considerable self induction and very little resistance, the potentials will equalize and then the current will continue in the same direction charging the plates of the condenser again but with reversed polarities. In order to restore the equilibrium, the current must flow in the reverse direction. It swings back again, restoring this equilibrium momentarily, but swings by, charging up the condenser again in the same direction until it finally stops, thus producing what we call an oscillating discharge. The essential elements of any oscillating system are a capacity and an inductance and a means for charging the capacity and allowing it to discharge through the inductance. Fig. 2 represents such a system.

An ordinary alternator charging a condenser C through inductance L′ and a resistance R′ with a discharge circuit for the condenser comprising an air gap in series with inductance L and resistance R is a source of high frequency currents which appear as oscillations in the circuit ABCD if the air gap is set for such a voltage E that it breaks down before the voltage across the condenser C has reached a maximum and if R is small compared with L.

The arrangement shown in Fig. 2 is called an oscillating current generator by Steinmetz, and a complete mathematical discussion of it is given in his book on "Transient Electric Phenomena and Oscillations." He shows that the condenser discharge will be oscillatory if R^2 is less than 4 L/C and that the frequency of the oscillating current is,

$f = 1/2\pi\sqrt{(1/LC - R^2/4L^2}$, or, if R is small, $f = 1/2\pi\sqrt{1/LC}$.

Where, f = frequency in cycles per second; L = inductance in henrys; C = capacity in farads; R = resistance in ohms.

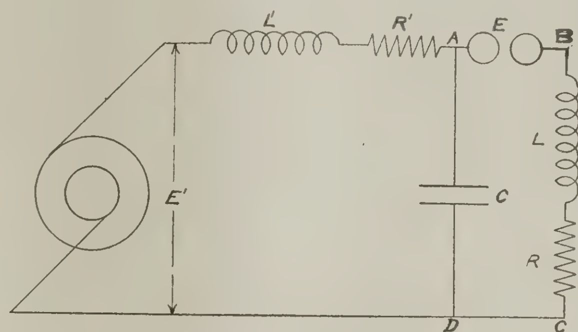


Fig. 2. Diagram of Oscillating Current Generator Circuit.

Suppose for example, that the insulation of a cable in a transmission system should weaken to such an extent that sparking from one conductor to another should start. Suppose that the short circuit burns off one of the conductors before the power is shut off. We will then have, momentarily, self-induction and resistance in series, with capacity across the line and an air gap with self-induction and capacity to discharge through. The result will be a high-frequency oscillating discharge. As an example of what may happen under such conditions, take the high-power surge which occurred in the high potential system of the Manhattan Railway in 1903. Regarding the occurrence Mr. H. G. Stott made the following comments, (Proceedings of the A. I. E. E., June, 1905):

"A summary of the happenings of that night in their proper sequence is:

"First, a static discharge over the high-tension insulators and cables was observed in sub-stations Nos. 7 and 8.

"Second, within a few minutes a feeder short circuited in the manhole nearest to the power-station, blowing out about 12 inches of three-conductor cable, and raising the manhole and pavement all around it with a loud report.

"Third, one of the six generators operating in multiple short circuited near the terminals, conductors on two turns of the winding being driven out until they struck the iron of the frame of the generator, that is to say, the armature bars, which are two inches by 1-8 inch, three in each slot, were bent edgewise for over six inches, showing that the force bending them probably amounted to at least 3,000 or 4,000 pounds.

"Fourth, practically simultaneously several of the three-conductor feeders from sub-stations 8, 4, 3, and 2 short circuited, some of them in the manholes at a greater or less distance from the power-station, and one across an end-bell in the power-station. No damage took place in the sub-station.

"Upon examination, one of the generators, which was apparently otherwise uninjured, showed that the current had jumped across between the end connectors near the end of one phase, a distance of four inches, through the air. At another point on another phase of the same machine marks showed that the current had jumped from one of the end bars

to the iron through the air, a distance of six inches. Other arcing distances showed conclusively that the potential must have risen to not less than 70,000 volts.

"The above is a brief resume of what happened. My own opinion is that the source of all the trouble was in the feeder in the manhole next to the power-station breaking down the insulation to ground. This caused the static to show up at the sub-station. The large capacity current of the system burned the insulation of the neighboring conductors in the three-conductor cable, and formed a short-circuit which blew out the arc, due to the sudden expansion of air in the manhole from the heat generated by approximately 70,000 kw. (each machine being capable of giving out 12,000 kw.) The arc was probably re-established several times, thus setting up an oscillating current, and giving rise to the potential above mentioned."

The fire which destroyed the Minneapolis General Electric Company's Main street station is thought to owe its origin to an oscillation of this sort. It will be remembered that on January 7, 1911, the plant of the Minneapolis General Electric Company was almost totally destroyed by a fire which is said to have originated with the short-circuiting of the 13,000-volt lines. The damage done to the company was estimated at $500,000.

An investigation and discussion of the Manhattan high-power oscillation is given by Steinmetz in the June, 1905, proceedings of the A. I. E. E. A careful study of this particular investigation is recommended to those who are particularly interested in high-power oscillations. In this paper Steinmetz makes the statement that 100,000 Kw. was concentrated in the short-circuiting arc in the manhole, and that the energy of 100,000 Kw. applied only one-tenth of a second equals the explosion of about half a pound of dynamite.

For a particular underground system which Steinmetz investigated, reported in his Transient Electric Phenomena and Oscillations, page, 877, the following constants are given: The capacity of the cable system is 102 microfarads; the inductance 6.4 milli-henrys; resistance of the generators and circuit up to the short-circuiting arc 1.1 ohms; impressed emf. 11,000 volts; and frequency 25 cycles per second.

The frequency of the oscillation in this case is,

$f = 1/2\pi\sqrt{(1/LC - R^2/4L^2)}$.

$f = 1/2\pi\sqrt{[1/(.0064(\,).000102)]} - [(1.1)^2/4(.0064)^2]$

$f = 197$ cycles per second.

If these values and the constants for the circuit are substituted in the equations Steinmetz has derived for the current and electro-motive force in the discharge circuit, enormous values will be obtained, thus giving us the conditions for a surge of enormous volume and low frequency, therefore, one that would be of wide extent and very great destructiveness.

The volume of the surge in the above, which is represented by the instantaneous short-circuit current, is approximately,

$I = E/\sqrt{[R^2 + (2\pi fL)^2]}$.

$I = 11{,}000/\sqrt{[(1.1)^2 + (2\pi)(25)(.0064)^2]}$.

$I = 7620$ amperes.

The pressure of the oscillation would be very roughly, actually be greater, $E = 2\pi fLI$, where, $f =$ frequence of the oscillation; $I =$ short-circuit current.

$E = (2)(197)(.0064)(7620) = 19{,}200$ volts.

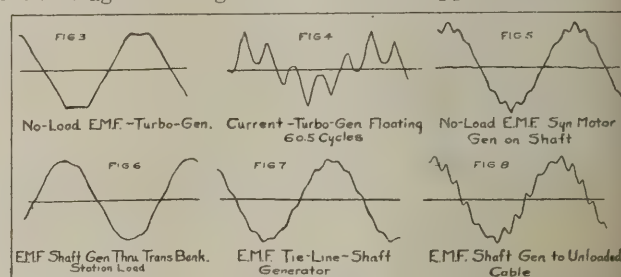
It is evident that such a surge of the frequency and volume represented by the above calculation would be exceedingly dangerous.

We have seen that the discharge of a condenser through a circuit containing L and R is oscillating (provided R does not exceed a certain critical value), that is, the discharge current alternates with constantly decreasing intensity, and that the frequency of this oscillation is,

$f = 1/2\pi\sqrt{[1/LC - R^2/4L^2]}$.

An electric transmission line represents a circuit having capacity as well as inductance and when charged to a certain potential, for instance by atmospheric electricity, as by induction from a thunder cloud passing over or near the line, the transmission line discharges by an oscillating current. Such a transmission line differs, however, from an ordinary condenser in that with the former the C and L are distributed along the line.

This makes the problem an exceedingly complex one. Steinmetz in his book on "Transient Phenomena," pages 321 to 342, has developed equations by which a fair approximation of what may be expected under various conditions may be made. He develops an equation for the fundamental frequency of oscillation, or the natural period of a transmission line; that is, the frequency at which such a line discharges an accumulated charge of atmospheric electricity, (lightning), or oscillates because of a sudden change of load, as a break in the circuit conditions, as closing the circuit or shifting the load to some other station, etc. He shows that this frequency is, $f = 1/4\sqrt{(CL)}$. In the case of a lightning discharge the capacity C is the capacity of the line against the ground. The same applies to L.



FIGS. 3 TO 8. OSCILLOGRAPH CURVES TAKEN UNDER DIFFERENT CONDITIONS.

If $d =$ diameter of line conductor; $h =$ height of conductor above ground; $l =$ length of line.

$C = (1.11)(10^{-6})l/2\log(4h/d)$ in m. f.

$L = (2)(10^{-6})l\log(4h/d)$ in mh.

Substituting C and L in the above equation, $f = 7{,}500{,}000{,}000/l$, where $l =$ length of line in cm.

If $l = 10$ miles, $f = 4700$.

If $l = 40$ miles, $f = 1175$.

If $l = 100$ miles, $f = 470$.

If $l = 200$ miles, $f = 235$.

The equation shows us that the frequency of oscillation is independent of the size of the conductor and of its distance from the ground, depending merely on the length of the line. As seen, these frequencies are comparatively low; for 200 miles it is pretty close to the third harmonic of a 60 cycle generator.

These figures are for an aerial line. If the line is partly underground, it would be much lower. The Minneapolis General Electric Co. transmits energy from Taylor's Falls, a distance of 40 miles. If this were entirely an aerial line its natural period would be 1175 cycles. At the city limits the pressure of 50,000 volts is stepped down to 13,200 volts and transmitted the remainder of the distance by underground cables; also their main station and their sub-stations are tied together by underground cables. Calculations made by Mr. W. J. Finke and presented to the local branch of

the A. I. E. E. gave results on some of these cable lines of from 300 to 400 cycles per second. Oscilograms taken some time ago by Messrs. Svendsen and Peterson, senior students in the electrical engineering department, showed the presence of very pronounced harmonics under certain conditions in some of their underground cables. In some instances the seventh and even the eleventh and thirteenth harmonics were very pronounced. Even seven times sixty is higher than from 300 to 400, hence the possibility of oscillations on lines with these harmonics present was clearly demonstrated.

Figs. 3 and 4 show the emf. and current waves of a 1,500 kilowatt turbo-generator on no load. Fig. 5 shows the emf. wave of a large generator connected directly to two underground lines but carrying no load. An analysis of this wave in accordance with the method given by Kitner in the *Electrical World*, (volume 43, page 1024), gives the following rather odd results:

HARMONICS IN PER CENT OF FUNDAMENTAL.

Third harmonic	00.173
Fifth harmonic	1.85
Seventh harmonic	0.72
Ninth harmonic	1.92
Eleventh harmonic	6.73
Thirteenth harmonic	8.12
Fifteenth harmonic	7.90

Fig. 6 shows the emf. wave when a load of about 350 kilowatts is thrown on. The harmonics are almost entirely lost. Figs. 7 and 8 are very interesting examples. They show the emf. waves on two tie lines, both of which are partly underground and partly aerial, and which are carrying only the exciting current of the transformers. Fig. 8 is from a line which is mostly underground. It is seen that the harmonics are greatly accentuated. An analysis of Fig. 8 gives the following results:

HARMONICS IN PER CENT OF FUNDAMENTAL.

Third harmonic	00.73
Fifth harmonic	2.3
Seventh harmonic	4.4
Ninth harmonic	0.98
Eleventh harmonic	9.30
Thirteenth harmonic	4.65
Fifteenth harmonic	2.40

Here again the eleventh and thirteenth harmonics seem to be accentuated at no load with considerable capacity in the circuit. Obviously, with the eleventh and thirteenth harmonics so pronounced and with the natural period of the line as low as 300 or 400 cycles per second, there was danger of high frequency currents when switching that might short-circuit a cable. This fire was said to have been started by a cable short-circuit.

It may be interesting to call attention to Steinmetz's constant potential, constant current, quarter wave length transmission line. His complete mathematical discussion is given in his book on "Transient Electric Phenomena and Oscillations," pages 279 to 341. An electrical impulse, if sent into the air or along an aerial line, (not in underground cables), will travel at the velocity of light, or 188,000 miles per second. If the line is open at the other end, the impulse is reflected and returns at the same velocity. If when this impulse reaches its starting point a second impulse of opposite direction is sent into the line, it will add itself to the first one, the return of the third adds itself to the second, etc. In this way large currents and high electro-motive forces may be produced by small impulses, that is, by low impressed alternating electro-motive forces. Suppose the line receives current at 60 cycles per second; the wave length would be $188,000 \div 60 = 3133$ miles from maximum to maximum. In other words, a line 3133 miles long would deliver a 60 cycle current to the load at the other end one cycle after it had been generated. Suppose the load is $3133 \div 4 = 783$ miles away. The generator will be generating zero potential when the receiver potential is a maximum. Therefore, alternating impulses occur at time intervals equal to the time required for an impulse to travel the length of the line and back, that is, the time of one-half wave of impressed electro-motive force, or, in other words, the length of the line is one-quarter wave length.

If an emf. of say 100,000 volts at 60 cycles, were applied to an aerial line 783 miles long, an enormous emf. would be produced at the other end. The insulation of the line would of course give way. In his book on Transient Phenomena, Steinmetz has shown that if just a small emf. and a certain current is supplied to such a line, you will get the emf. you want, say 100,000 volts, at the receiver end at no load. As load comes on at the other end, the emf. supplied must be increased to keep up the emf. at the receiver end, but the current supplied by the generator remains approximately constant. Therefore, at the receiver end he gets a constant emf. with varying current, by supplying a quarter wave length line with a constant current and a varying emf. at the generator end, or by supplying constant current to the line, constant voltage is maintained at the other end. It might, therefore, be termed constant-current-constant-potential transfomation.

Development of Electric Lighting in New Zealand.

The development of water power resources will doubtless make electricity the most important illuminant of the future in New Zealand, but the use of acetylene, kerosene, and candles will probably continue in the country districts, electricity chiefly superseding coal gas, now used in the larger towns. At present Wellington and Dunedin have the most electric lighting of any New Zealand cities. In both cities electricity is supplied from municipal street railway plants.

An electric power station was opened at Auckland in 1907, and the growth of the demand for electricity for light and power purposes has been so great that the citiy corporation has just acquired a new site of 4 acres on the harbor front, on which it is intended to erect a large modern power house. The charges are lower than at Wellington, though somewhat higher than at Dunedin, where water power is used. Most of the gas works of New Zealand are owned by private companies, and are operated in an efficient and enterprising manner. These companies are doing all they can to encourage the use of gas for heating and cooking, to make up in this direction the business that they will lose by increased use of electricity as an illuminant through cheaper water power. The city of Christchurch, which now depends almost entirely upon gas supplied by a private ompany, is to be the first ity to be given the benefit of cheap electricity, as the first important water power development to be put under way by the Government will be at Lake Coleridge, near that city.

The Cost of Generating Electrical Power in Small Plants.

An Impartial Treatment of the Subject, With Calculations for a Typical Case.

THE question of installing an isolated plant equipment in a territory served by a central station is not to be settled by guess work or prejudice in these days with central stations adopting carefully worked out rate systems. In every case the conditions must be studied and a decision based upon good engineering with a financial interpretation. Undoubtedly one of the largest inroads upon central station service that the private electrical plant has, is through the demand for exhaust steam for manufacturing purposes and its use for heating. Even in these cases the problem requires the best engineering skill and a thorough knowledge of the conditions necessary for low cost of generation. An isolated plant in some cases is the proper solution, however, without a thorough investigation it may be found a most unprofitable investment and in such cases a handicap to a business on account of the capital that is tied up.

The factors to be taken into account in the actual solution of a particular case was given careful treatment by a writer in a recent issue of the *Canadian Electrical News*. In what follows an abstract of the treatment is given which may be of assistance to both central station engineers and owners of industrial plants where the subject of cost of power is being considered. The case taken is fairly typical of those cases where power is to be generated by non-condensing engines with the exhaust steam used for heating during the winter season.

The calculations necessary for determining the cost of power are given and the influence on the cost per Kwh. of the three most important factors, namely, fixed charges, price of coal, and the amount of exhaust steam used for heating, plainly set forth.

Fixed Charges.

The case assumed was an industrial plant operating 3000 hours per year with an average load of 200 Kw. Two 100 Kw., and one 50 Kw. engine driven dynamos installed with suitable piping and appurtenances may be set down at $11,000. Two 200Hp. boilers would also be required. However the total cost of these boilers would not be chargeable against power, since boilers would also be required for the low pressure heating plant. The cost per Hp. of low pressure boilers, grates, stack, etc., is about the same as a similar high pressure equipment. However, as heat is lost and consumed between the high pressure boiler and the heating system, a somewhat greater boiler capacity must be installed when power is to be generated. As the exhaust from an engine contains 80 to 90 per cent. of the heat given it in the boiler, an increase of boiler capacity of 20 per cent. over the low pressure equipment will take care of this item and also any additional cost of a high pressure boiler as compared to a low pressure equipment. Seting down $18.75 per horse power, including boiler, grates, stack setting, piping and labor of installation, the additional boiler cost is 400 Hp. x 20 per cent. x $18.75 equals $1,500

Of this total additional cost of $12,500, a certain fixed percentage must be charged off every year against the cost of power. The fixed charge may be set down as follows:—

Interest at 5 per cent	$ 625.00
Depreciation at 5 per cent	625.00
Insurance, real estate, upkeep, obsolescence, 5 per cent	625.00
Total, 15 per cent	$1,875.00

Labor, Oil-Waste, Etc. The cost for additional labor may be taken as one man at $800 per year, while repairs, oil-waste, packing, etc., may be set down as $250, making a total of $1,050.

Coal. The coal chargeable against power comprises the coal equivalent of the heat lost between the high pressure boiler and the heating system when the heating season is on, and when no heating is being done, all of the coal burnt under the boiler is chargeable against power. The cost for coal will, therefore, depend upon: (a) the steam consumption of the engines per Kwh.; (b) the efficiency of the boiler, or pounds of steam per pound of coal; (c) the cost of coal, and (d) the percentage of the total amount of steam generated which is used by the heating system.

Item (a). Steam consumption may be placed at 30 lbs. per horse-power-hour (non-condensing), or 40 lbs per kilowatt hour. To be on the safe side and to take care of the effect of reduced and fluctuating loads on steam consumption, assume 60 lbs. of steam per Kwh.

Item (b). Assume boiler efficiency as 60 per cent., or about 8 lbs. of steam per pound of coal.

Items (c) and (d). The cost of coal and the proportion of the total steam generated which is used in the heating system, are both variable. In the table given herewith, the cost of coal ranges from $1 to $5. The amount of steam used in the heating system is taken care of by considering the number of equivalent months of the year when all the exhaust steam is used for heating. During those months it is assumed that all the exhaust steam is used by the heating system. Strictly speaking, at the beginning and end of the heating season, there are periods when only a moderate amount of heating is required and only a portion of the steam exhausted by the engines is utilized. This decrease in heating load may be taken care of by assuming a shorter heating season. For example, suppose that for four months during the winter, all the exhaust steam was used in the heating season and that for one and a half months before and after this season the amount of steam used in the heating system varied from zero to full capacity. It would then be quite accurate to assume that the heating season of seven months would be equivalent, as to amount of steam used for heating, to a season of five and a half months in which heating load was always equivalent to the full exhaust of the engine.

Water. An average price for water is 10 cents per

1,000 gallons. During the heating season it is assumed that only eighty per cent. of the water is returned to the boiler. During other periods all the water is lost. It should be noted that it is assumed that in a low pressure heating system all the water is returned to the boiler, that is, there is no loss, and in setting down the additional cost of water when power is produced as a by-product, it is assumed that condensation in high pressure steam piping, condensation in the engine, etc., results in a twenty per cent. loss during the heating season and when the steam is exhausted to atmosphere, a one hundred per cent loss. With the fixed costs and labor cost already given, and calculating the coal and water charges for given conditions, the table and charts shown were obtained. The following example will serve to explain in detail the method of arriving at these figures.

Example. Assume the heating season equivalent to six months of full load steam heating, during which all the exhaust is used. During this period the coal chargeable against power is the equivalent of the steam and heat lost between the high pressure boiler and the heating system. Assume that twenty per cent. of the heat of the steam is lost in this manner. The other factors entering into the coal cost have already been given, that is, load, 200 kw.; steam consumption, 60 lbs. of steam per Kwh.; coal consumption, 1 lb. of coal per 8 lbs. of steam.; hours per year, 3,000. With coal at $4, we then have the cost for coal during the six months heating period, as follows:

$(200 \times 3000 \times 60 \times 20 \times 4)/(2 \times 8 \times 2000 \times 100) =$ \$900.

The part of the year when there is no exhaust steam heating, and those parts of the year when only part of the exhaust steam is used for heating, are equivalent to six months of straight non-condensing operation. The cost of coal is therefore:

$(200 \times 3000 \times 60 \times 4)/(2 \times 8 \times 2000) =$ \$4500.00.

To this coal cost must be added the cost for water which may be set down at 10 cents per thousand gallons. During the heating season the system returns 80 per cent. of the boiler feed. The cost for water is then (8.33 lbs = 1 gal.):

$(200 \times 3000 \times 60 \times 20 \times 10c.)/(2 \times 8.33 \times 100 \times 1000) =$ \$43.20.

For the other six months the cost for water is as follows:

$(200 \times 3000 \times 60 \times 10c.)/(2 \times 8.33 \times 1000) =$ \$216.

We may now set down the total charges for generating power at the rate of 200 kw. for 3,000 hours a year, as follows:

Fixed charge	$1,875.00
Labor, oil and miscellaneous	1,050.00
Coal	4,500.00
Coal for 6 mos. heating	900.00
Water	216.00
Water for 6 mos. heating	43.00
Total	$8,584.00

During the year there are developed $3{,}000 \times 200 = 600{,}000$ Kw. hours, giving a cost per Kwh. of $\$8{,}584 \div 600{,}000 = 1.431$ cents.

In the same manner it is found that when the heating season is equivalent to only two months of full-load heating, the cost per Kwh. is 1.85c. For the same conditions when the price of coal is $5 instead of $4, the cost per Kwh. is 2.175c. In this way the table following was compiled:

Table 1. Cost of Power per Kwh. in a Typical Isolated Plant. Average Load 200 Kw.

Months of Exhaust Steam Heating	Price of coal in $ per ton. $0	$1	$2	$3	$4	$5
2	.550	.880	1.200	1.525	1.850	2.175
4	.540	.820	1.090	1.365	1.640	1.915
6	.531	.755	.983	1.205	1.431	1.656
8	.521	.700	.871	1.046	1.221	1.396

Charts. From this data the charts of Figs. 1 and 2 were prepared. In Fig. 1 the cost of power in cents per Kwh. (average over the whole year) is plotted against the number of months that exhaust steam is used for heating. Each line represents a different price of coal. With this chart in hand, we can study the influence of coal cost, length of heating periods, the influence of first cost and also of percentage of that cost which should be charged off per year in order to take care of interest, depreciation, etc.

Suppose, for instance, as has already been suggested, that instead of considering the additional cost of a high pressure boiler plant and engine, as against a low pressure boiler plant, we desire to find out the cost of power in a plant where a low pressure boiler is already installed and must be replaced. The additional first cost of the high

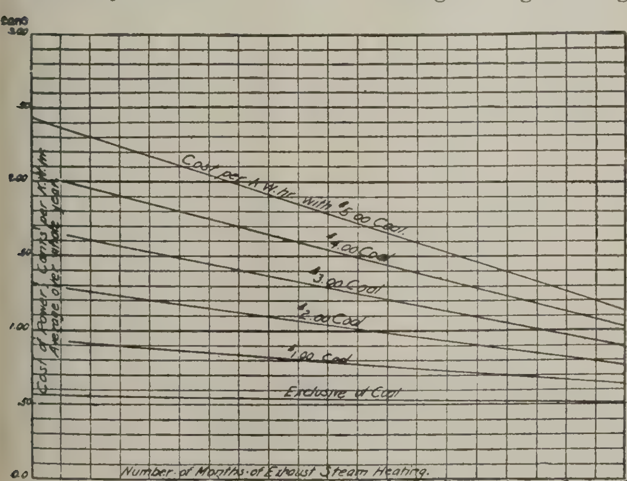


Fig. 1. Cost of Power per Kwh. for Months of Steam Heating.

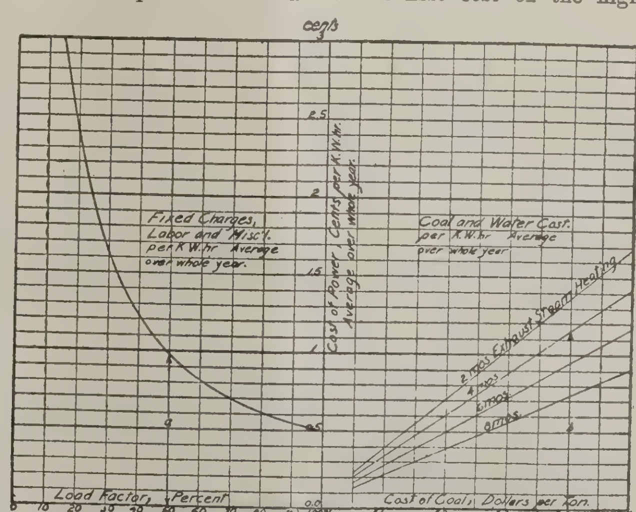


Fig. 2. Cost of Power per Kwh. for Different Prices of Coal.

pressure boiler over and above the low pressure boiler, taking into account the fact that a boiler of high capacity would be required, was set down in the foregoing analysis at \$1,500. Assume that an entire new boiler would be needed costing five times this amount, or \$7,500. This would increase the additional first cost of the plant by \$6,000 and the additional yearly charges by 15 per cent. of \$6,000 or \$900, making the total fixed charge \$2,775, instead of \$1,875, and for 600,000 Kw. hours per year, would increase the fixed charge per Kwh. from .312 cents to .462 cents, or an increase of .150 cents. The influence of this additional charge of .150 cents upon the cost of power with \$4 coal, and when three months' exhaust steam heating is used, is therefore an increase from 1.75 cents to 1.90 cents per Kwh.

In the chart of Fig. 2 the cost per Kw. hour is plotted against the cost of coal in dollars per ton, and each line represents the cost for different lengths of heating periods. This chart is useful for investigating the effect of the price of coal and also the comparative effect of length of heating season and price of coal. For instance, the cost per Kw. hour is practically the same for an eight months solid heating season with \$4 coal, as it is with a two months heating season with \$2 coal.

On reference to this chart, it will be noted that the cost, exclusive of coal and water, are considered separately—being plotted against load factor. A load of 200 Kw., 3,000 hours per year, is considered as 100 per cent. load factor (although the plant capacity is 250 Kw.) At 100 per cent. the fixed charge, labor charge, etc., per Kwh. is (\$1,875 + \$1,050)/600,000 = .488 cents. Similarly at 50 per cent. load factor the cost per Kwh., exclusive of coal and water, is (\$1,875 + \$1,050)/300,000 = .976 cents.

By similar calculations the complete curve is plotted, which may be used in connection with the curves at the right in order to study the cost of power under various conditions. Suppose, for instance, that the load factor is fifty per cent., then the ordinate "a" = 98 cents = fixed charge, labor, etc.; if the coal cost is \$4 a ton and the number of months exhaust steam heating is 4, then the coal and water cost per Kwh. is given by "b" which equals 1.17 cents and the total cost of power per Kwh. equals a + b = 2.15 cents.

Now, the question that naturally arises in the mind of the consumer of electric current is this: If the isolated plant with its small capacity and efficiency, further decreased by the fact that it must exhaust its steam for a part of the year to atmosphere, can generate power for two cents a Kwh.—why is it, that the central station, in which maximum economy is obtained by cutting down all losses, generating in large units, operating condensing, etc., cannot generate power at a far less cost than this and sell it for a price approximating one to two cents per Kwh.?

The central station can produce power at its own switchboard for a cost, including both operating and fixed charges, of one cent per Kwh. But this is only a part of the total cost to the consumer, since it is necessary to have an elaborate and expensive transmission and distributing system of copper cable, feeders, sub-stations, etc., in order to deliver the power. The power house furnishes electricity to the distributing system, which acts as a carrier and which must pay interest, depreciation, franchise and maintenance charges just as must a railroad.

A Study of Polyphase Relations by Kirchoff's Laws.

(Contributed Exclusively to SOUTHERN ELECTRICIAN.)

BY B. C. DENNISON, ASST. PROFESSOR ELECTRICAL ENGINEERING, CARNEGIE TECHNICAL SCHOOLS, PITTSBURGH, PA.

The Solution of Various Problems, Giving the Vector Relations. Continued from May Issue.

3A. THREE-PHASE STAR-CONNECTED SYSTEM. PRESSURE RELATIONS.

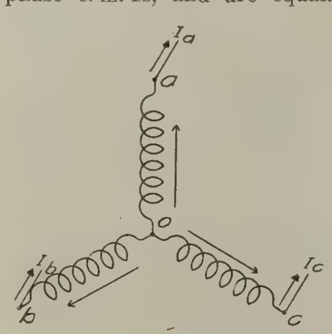
In the star (Y) connected system of Fig. 12 the three emfs, Eoa, Eob, Eoc are equal and displaced 120°. The vectors of these quantities are shown in Fig. 13. The e. m. f. between any two line wires, as the e. m. f., Eab, is found by application of rule II—b. Thus, since the phase emfs are measured both away from the point, O, Eab = Eob — Eoa. This vector difference is shown in Fig. 13, and it is evident from the geometry of the figure that Eab = $\sqrt{3}$ Eob and leads it by 30°. Thus in a three-phase, Y-connected system the line emf = $\sqrt{3}$ times the phase emf.

CURRENT RELATIONS. Of necessity the line current must equal the phase current. With balanced non-inductive load the line current is in phase with the phase e. m. f. and lags 30° behind the line e. m. f., as seen in Fig. 13.

3B. THREE-PHASE DELTA-CONNECTED SYSTEM.

PRESSURE RELATIONS. To satisfy the conditions of a symmetrical three-phase system the three e. m. fs of Fig. 14, when measured all in, say a counter clockwise direction, must differ in phase by 120°, must be equal, and their vectors, therefore, must form a closed polygon. This is shown in Fig. 15. Evidently the e. m. f. between lines of the delta-connected system equals the phase e. m. f.

CURRENT RELATIONS. The currents in the phase windings at balanced non-inductive load, are in phase with the phase e. m. fs, and are equal. To find the line current,



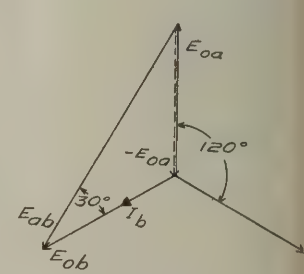


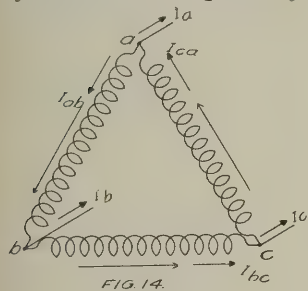
FIG. 12. THREE-PHASE Y CONNECTION. FIG. 13. RELATIONS IN THREE-PHASE Y-CONNECTED SYSTEM.

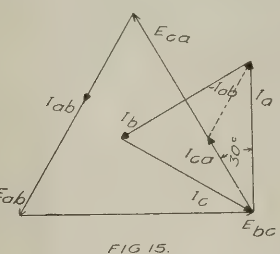
Ia, measured away from a, Law Ia is applied giving that Ia = Ica — Iab. As is seen from Fig. 15, Ia = $\sqrt{3}$ Ica and lags 30° behind the line pressure, Eca. Similarly Ib and Ic lag 30° behind the corresponding line pressures. Thus, in a symmetrical three-phase Y-connected system with balanced load the line current equals $\sqrt{3}$ times the phase current.

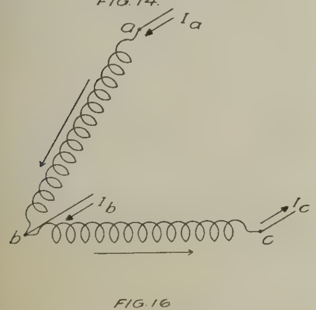
With balanced inductive load the same relations exist except that Ia lags by 30° + Θ, where Θ is the angle $\cos^{-1}$ = power factor.

4. THREE-PHASE V-CONNECTED SYSTEM. PRESSURE RELATIONS.

Two generator or transformer windings may be connected in "V," as illustrated in Fig. 16, and still produce three equal emfs displaced by 120°, i. e., they produce a symmetrical three-phase system of pressures. Referring







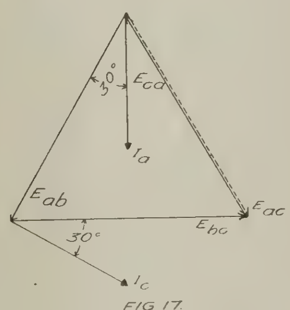


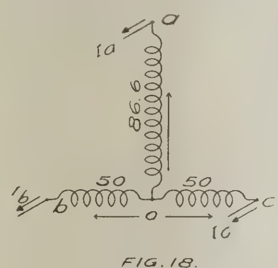
Fig. 14. Three-Phase, Delta Connection. Fig. 15. Relations in Delta System. Fig. 16. Three-Phase V-Connection. Fig. 17. Relations in V-System.

to Fig. 17, the two emfs generated, Eab and Ebc, measured both in a counter clockwise direction are at 120°. The emf from a to c is the geometric sum of Eab and Ebc or Eac, shown by a dotted line. This is measured in a clockwise direction; when measured in a counter clockwise direction, in common with the other two emfs, the pressure Eca results and completes the necessary conditions for the three-phase system of pressures. In the V-connected system the line pressures and phase pressures are equal.

Current Relations. The current relations are similar to those in the delta-connected system (see Figs. 14 and 15) except that the phase windings carry the line currents. Thus, if currents are measured as indicated in Fig. 16, the current Ia, measured toward a, since it must be the difference between the currents Iab and Ica of the delta system of Fig. 14 will have the value, $\sqrt{3} \times$ Iab, and will, with the signs as chosen in the diagram, lead the pressure Eab by 30°, for balanced non-inductive loads. Ic similarly lags 30° behind Ebc. Thus, the phase current in V-connected system is $\sqrt{3} \times$ the phase current in the delta-connected system, and is not in phase with the winding pressure. Evidently the machine will not have the output capacity which it did on delta connection, both on account of the lowered power factor and the use of but two windings. For a given current per phase the output of the V-system is 2/3 × cos 30° = 0.578 times that of the delta system.

5. THREE-PHASE T-CONNECTED SYSTEM. PRESSURE RELATIONS.

Consider the three equal pressures of a symmetrical three-phase system to be connected to the three terminals, a, b, c, of two transformers connected as in Fig. 18. If the turns in the transformer windings be in the ratio of 86.6 to 100 the pressures Eoa, Eob and Eoc will be as 86.6, 50 and 50 volts, respectively, and must have the relative phase displacements shown in Fig. 19, i. e., Eoa is displaced 90° from either Eob or Eoc. It follows, therefore, that two generator windings, if displaced on the armature by 90 electrical degrees, and having the ratio of turns of 86.6 to 100, may be connected in T to produce a symmetrical three-



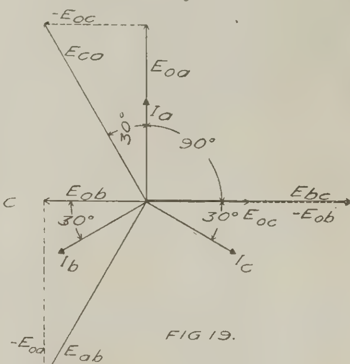


Fig. 18. The T-Connection. Fig. 19. Vector Relations With T-Connections.

phase system of pressures. As stated above two transformers may be connected in T, to a three-phase system. If the secondary windings be also connected in T a transformation of three-phase power from one pressure to another will be effected with but two transformers.

CURRENT AND POWER RELATIONS. A. BALANCED NON-INDUCTIVE LOAD.

As has been shown in Figs. 13 and 15, the three line currents of a three-phase system on balanced non-inductive load lag 30° behind their respective line pressures. With the T-connection, as shown in Fig. 19, this brings the line current Ia in phase with Eoa, the current Ib is 30° ahead of Eob, and Ic is 30° behind Eoc.

For a line current I and line pressure of E the output of the transformers is,

$$W = E_{oa}I + E_{ob}I \cos 30° + E_{oc} I \cos 30°$$
$$= .866\ E I + 0.5 E I \times 0.866 + 0.5\ E I \times 0.866$$
$$= 1.73\ E I$$

The rating of three such transformers connected in delta to 3 E I so that the ratio of ratings, T-connection and delta-connection, is 1.73 to 3 or 0.578 to 1. Thus, the T-connected and V-connected systems have the same capacity for a given size of transformer.

B. BALANCED INDUCTIVE LOAD.

As the load becomes inductive the currents are affected as follows: Current Ia lags Θ° behind Eoa, Ib lags Θ—30° behind Eob, while Ic lags Θ + 30° behind Eoc.

6. THREE-PHASE TO TWO-PHASE TRANSFORMATION, SCOTT SYSTEM.

This is accomplished by two transformers having ratio 86.6 to 100, connected with their primary windings, in T and with the secondary windings, usually of equal turns, connected independently. This is illustratetd in Fig. 20.

From the discussion of the T-connection for three-phase transformation it should be evident that if two independent and equal secondary windings be employed they will constitute a two-phase supply, and energy is transformed from the three-phase to the two-phase condition. The pressure and current relations are those of the T-connection already discussed. Fig. 19, therefore, gives the relation of the various quantities.

7. THREE-PHASE TO TWO-PHASE TRANSFORMATION—THREE TRANSFORMERS.

Instead of the Scott system of phase transformation, three transformers may be connected as in Fig. 21. The primary windings are connected in delta and the secondary windings, two of which have taps at 86.6% and one a tap at 50% of the total winding, are also in delta. The scheme of connections is shown in Fig. 21. From the relations met in the V-connection it will be seen that the pressure, Ef′d′ equals the pressure Ea′d′ and has the direction shown in Fig. 22. Likewise the pressure Ea′c′ equals Ea′b′ plus ½ Eb′e′ = 0.866 Ea′b′ = Ef′d′.

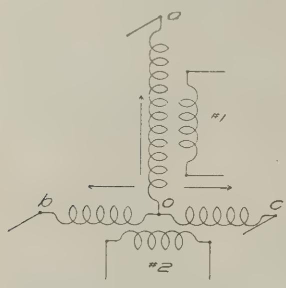


FIG. 20

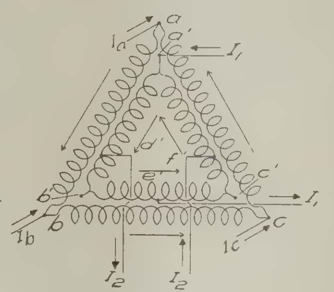


FIG. 21.

FIG. 20. THREE-PHASE, TWO-PHASE TRANSFORMATION, T-CONNECTION. FIG. 21. THREE-PHASE, TWO-PHASE TRANSFORMATION WITH THREE TRANSFORMERS.

Thus these two pressures are equal, and, as seen in the diagram, are displaced 90° with respect to each other, i. e., they constitute the pressures of a two-phase system. This is not, however, a symmetrical quarter-phase system, for the pressures between adjacent terminals, as a′ to d′ and from d′ to b′, are unequal and are not at 90°. This supply is not suitable, therefore for quarter or two-phase mesh connected loads, due to the lack of symmetry. For two distinct loads it is quite suitable, however, as for two-phase machines in which the phase windings are independent.

CURRENT RELATIONS. Considering the same number of turns, total, in primary and secondary windings, the line currents will have the ratio found from the relation, $\sqrt{3}EI_3 = 2 \times 0.866EI_2$, or $I_3 = I_2$, so that the current per line wire, in the three-phase supply, equals the line current of the two-phase load, assuming balanced load.

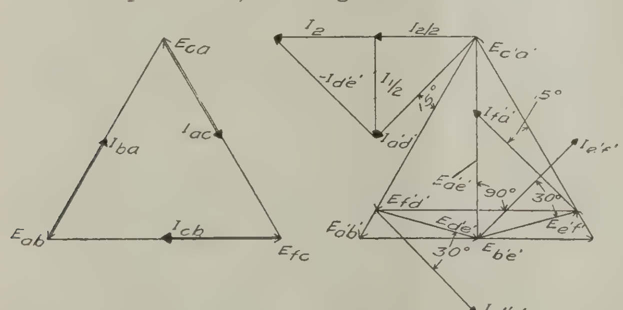


FIG. 23.

FIG. 22. RELATIONS IN PRIMARY AND RELATIONS IN SECONDARY WINDINGS OF CASE IN FIG. 21.

Current per phase and current in each section of the windings. The current per winding of the primary is $1/\sqrt{3} \times$ current per line as in any delta connection. With non-inductive loads these currents are in phase with the phase pressures, as shown in Fig. 22.

The current Ia′d′ may be considered as consisting of $I_2/2$ and $I_1/2$, at right angles, as in Fig. 22. The other half of I_1 flows down the right hand path from a′ to e′, and If′a′ = $I_2/2$ minus $I_1/2$, since the latter current goes against the assumed positive direction.

Proceeding in this manner the currents in the four sections found to be as in Fig. 22. Each current = $1/\sqrt{2} \times I$, where I is the line current, thus the various sections are loaded equally.

POWER RATING. Considering equal turns, primary and secondary, the line currents, I, have been seen to be equal. The current per phase of the primary is $I/\sqrt{3}$. The current per section of the secondary is $I/\sqrt{2}$, i. e., the primary current and secondary current have the ratio of 0.578 to 0.707. Thus the rating will be determined by the larger

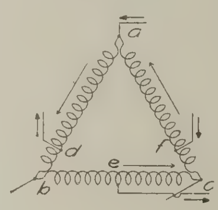


FIG. 23

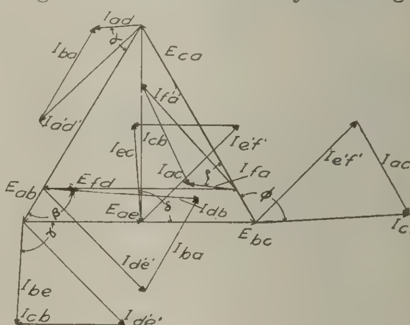


FIG. 24.

FIG. 23. PHASE TRANSFORMATION BY AUTO-TRANSFORMERS. FIG. 24. RELATIONS IN AUTO-TRANSFORMERS.

two-phase current and the three transformers will have a capacity, three-phase to two-phase, of .578/.707, or 0.82 times the rating when connected for three-phase to three-phase.

7B. PHASE TRANSFORMATION WITH AUTO TRANSFORMERS.

Instead of using transformers with a ratio of turns of 1:1 it is possible to dispense with the secondary windings and connect the same windings to three-phase supply and to two-phase load, as in Fig. 21. In this case the primary and secondary currents are superimposed, as in Fig. 24. This is obtained by combining the vector diagrams of Fig 22. It will be seen that the current in sections (ad) and (fa) is almost zero, while the currents in sections (db) and (fc) are slightly greater than with separate primary and secondary windings. The currents in sections (be) and (ec) are slightly less than with the former connections. Thus, it would seem possible to economize in a part of the windings by using wires of smaller cross section.

Other systems and methods of connection than those here treated will often arise, and it is hoped that the system here followed may prove suggestive in the solution of such problems. The next section will take up further problems for analysis.

A very small percentage of moisture will ruin transformer oil as it greatly decreases its dielectric strength. Great care should be exercised in handling oil to prevent the moisture from getting in same. Tanks and drums should be washed with gasolene and carefully dried before the oil is placed in same.

Features in Design of a 30,000 K. W. Central Station.

BY IRVING E. MOULTROP, CONSULTING ENGINEER FOR EDISON ELECTRIC ILLUMINATING CO., OF BOSTON.

The Details of Station Design.

Passing now to the details of the station we will commence in the boiler room. But before taking up the details I will say that there are two chief types of stations to be considered, one where the location is in a crowded community on high-priced real estate, making it imperative to use the least possible amount of land, and the other is where the station is located on the outskirts of the city or where real estate is low in value and the design is not necessarily hampered by real estate costs. The latter is the situation usually met with today, and from now on my remarks are confined to a station of this type. When the other situation is met the same general principles have to be considered, but the station design is bound to be more unsatisfactory.

The boilers should always be placed on one level. There are two general arrangements of boilers, either in two rows facing each other, the rows running parallel with the row of prime movers, or groups of boilers in a row, each row running at right angles to the row of prime movers. Both arrangements have some merit, and both should receive due consideration. Sometimes the arrangement is automatically settled by the shape of the real estate and its dimensions with reference to the fuel and water supply. The boilers should be located on the second floor of the boiler house, or in other words, there should be a large basement underneath the boilers. It may sound strange to say that it is desirable to put the large, heavy masses of brickwork and ironwork up in the air, but when you consider the amount of space required for the handling and disposal of the ashes and have made ample provisions for this work you have substantially made the boiler room the second floor, and I have yet to see a station anywhere where they had too much room in the spaces between the boilers.

No matter how large and convenient the storage space for coal outside the boiler room is, there should be coal bunkers above the boilers for a station the size we are considering, because the quantity of coal handled is so great that it is economy to handle it by machinery, and all machinery of any kind whatsoever is liable to break down or to meet with accidents. To my mind the most satisfactory arrangement is to make the overhead bunkers just as small as possible, say from a day and a half to two days' supply, and to keep all the storage of coal outside the building. This day and a half or two days' supply is ample to tide over any of the ordinary delays due to accidents with the coal handling machinery and at the same time keeps the weights to be carried in the top of the building down to a minimum, and likewise reduces or eliminates the danger of spontaneous combustion or the heating of the coal in the bunkers. The bunkers should be so arranged that they automatically empty themselves, thus eliminating the necessity of trimming the coal in the bunkers and keeping the supply of coal in the bunkers fresh. On account of the dust arising from the handling of coal, the bunkers should be entirely cut off from the rest of the boiler room; in fact, there should be no opportunity anywhere for the coal dust to escape into the boiler room. Ash hoppers of generous capacity should be constructed beneath the furnaces. By generous capacity I mean having sufficient size to store the ashes made in one and a half to two days' run. The ash hoppers should be built of or lined with fire resisting material so that hot clinker or even a certain amount of combustible on fire will not damage them. Moreover, they should be so designed that they require no trimming and discharge their entire contents without manual labor.

The arrangement of chimneys and the flue connections are other things that offer considerable scope to the ingenuity of the engineer. Both chimney and flue capacities should be very liberal, and especially so if the boilers are run on natural draft. The chimney area and its height should be of such proportions that, no matter how adverse the atmospheric conditions may be, the fireman will always have ample draft to meet the demands for power. Long horizontal flues must be avoided and the top flues should never be level, the greater the incline the better.

Boiler settings should be substantially built and of the best material. The best fire-brick on the market today has a comparatively short life in the hotter parts of the setting and the expense of renewing the burnt-out brickwork is a considerable item in the up-keep of the boiler room. Special attention must be given to the workmanship throughout. I believe there is much opportunity for improvement in the present methods of building boiler settings. There are very few brick settings that have been in use for any length of time which are not more or less cracked, thus allowing infiltration of air which is a direct loss. Some attempts have recently been made to wholly encase the boiler setting with cast iron or steel, which is a step in the right direction. This construction, however, is very expensive, as such a casing costs a good deal of money and has to be well made. It must be air-tight, and at the same time practically the same amount of brickwork is required to protect the casing from the heat of the fire.

It goes without saying that a station of the size that we are considering must be equipped with mechanical stokers. There are a large number of types of stokers on the market and each type has some merit. They all have some defects. They can be divided into two general classes—the natural draft and the forced draft type, and then these classes can be subdivided into underfed and overfed. The forced draft stoker has an enormous overload capacity, and in theory the air control is positive. I think one common defect with most stokers of this type is that they are cramped in the area of the combustion chamber, and this is also true of many types of the natural draft stokers. While it has been a well-known fact for many years that a large combustion chamber was necessary to obtain good combustion, this fact has apparently been lost sight of by nearly all classes of engineers.

To my mind the ideal stoker is one that will produce

complete combustion (which also means smokeless operation under all conditions of load), will be self-cleaning, will run economically on light loads and have a large overload capacity. It must have the fewest possible number of working parts in the fire or exposed to the heat of the fire; it must deliver its coal uniformly over the entire surface of the grate; it must have a minimum of repair charges and be capable of operation with practically no manual labor. In the choice of stokers one must carefully consider the kind of fuel that will be used in the station, as oftentimes a stoker which will handle one kind of fuel very nicely will be very unsatisfactory on some other kinds of fuel. Of course it cannot be expected that the station will always have the same kind or quality of coal to burn. The coal from one mine may not always run alike, but the general characteristics of the coal in a local market will not vary materially over a reasonable period of years, and a stoker should be selected that will best handle the coal usually found in the local market.

The stoker with its driving engine is the only moving machinery which in my mind should be placed in the boiler house, excepting, of course, the coal and ash handling machinery. Boiler feed pumps should never be placed in the boiler house; they do not belong there and usually the boiler room attendant is not the proper man to put in charge of boiler feed pumps. These pumps should be installed with the auxiliaries of the prime movers and under the charge of the man operating the rest of the moving machinery.

The piping of the boiler house is an interesting problem, and usually is never twice alike. The first consideration in the piping layout is whether the ring system or whether the unit system is to be employed. The former has the advantage of perfect flexibility; that is, any boiler can be run on any prime mover, but it entails more piping, which means a larger first cost; and more joints and valves, which means more up-keep and larger radiation losses. The unit system with suitable ties between the units is the more compact, direct, and economical one, and if the tie connections are properly arranged it has a reasonable amount of flexibility. The common practice is to put the steam mains in the boiler house above the boilers, and it is usually easy to obtain a rational design with this location, but it has the disadvantage of putting a lot more weight above the boilers; it is not so easy to get adequate supports for the ppiing and the piping is apt to be more difficult to inspect and repair. In my opinion it is much better to put the mains for the steam, water, blow-off, etc., in a portion of the basement or room beneath the boilers. By using some ingenuity it is possible to arrange a pipe room beneath the boilers, which will contain all of the pipe mains with nothing but the branch pipes going through the floor to the boilers above. This room should be cut off from the ash room proper by tight walls, and then an even temperature is maintained at all times, and in cold weather the pipes are not subjected to strains due to contraction by the cold air. All necessary flexibility can be obtained in the branches running up through the floor, and ample provision can be made for the proper support of the various mains. They can also be so arranged that they may be easily inspected and repaired. An arrangement of this kind usually means a much shorter steam main, which is economical both in first cost and in the loss of temperature if superheated steam is used.

In the general arrangement of the boiler room suitable permanent facilities should be provided for the operators to get to every point to which their duties call them. Ladders and planks are not only an abomination but are also a menace to the safety of the operators, and they are usually somewhere else when they are wanted in a hurry. The matter of light and ventilation of the boiler room and ash room, and all parts of the boiler house, should be given the same thought as in the engine room or in any other portion of the property. They are just as essential to the proper operation and welfare of the boiler room employees as they are to any other class of workmen.

THE ENGINE ROOM.

In the case of the station we are considering this is more properly termed "the turbine room." The light and ventilation should be given first consideration, and special care should be taken to have ample daylight everywhere, and a thorough system of ventilation. The next consideration should be that of the overhead traveling crane which should be so installed that it will conveniently reach all pieces of apparatus in the room and be of sufficient capacity to handle pieces of apparatus much heavier than anything in the present installation. If the turbine room structures consist of steel frame with walls of brick or concrete, do not make the mistake of putting the crane into service before the walls are built at least as high as the level of the crane rail, for the building frame will not have sufficient cross bracing to safely withstand the stresses due to running the crane lengthwise of the room.

We will assume that the prime movers and generators have already been determined upon and ordered, but there still remains all of the auxiliary apparatus to be provided for. In selecting the type of apparatus and determining upon the size of each type, care must be taken that each piece of apparatus is of ample capacity for the work it will be called upon to do. In the ordinary power plant a shut down of a piece of apparatus or even the entire plant is objectionable and expensive, but is not usually prohibitive. But an electric supply station, especially if it is furnishing light and power to a community, must always be ready to meet every demand of the customers connected to the system. There is only one class of service I call to mind which is any more strenuous in its demands for continuity of service than the station we are considering, and that is the blowing plant for steel works. Even there, a shut down means only an excessive loss in output and damage to cupolas whereas a sudden shut down to an electricity supply station might cause a panic in a crowded theater or some other meeting place and result in loss of life. Furthermore, the period of maximum load on an electricity supply station extends over a period of a number of months during which time every piece of apparatus is either in almost continuous operation or must be ready for instant service on demand. The power plant of a trans-Atlantic liner has to meet practically these same conditions, but only for a period of five or eight days, and then the entire plant is shut down for several days and can receive a general overhauling, but during the maximum load on the station there is no time to do any general overhauling.

To obtain this continuity of service all of the apparatus should be of ample capacity and of such size that in normal operation it is worked at a moderate rate. These points must be always kept in mind when selecting reciprocating pumps, and in determining on the size of the condenser and the size of the piping handling water.

The ideal argument of a turbine room to my mind is one where all the auxiliaries of the individual prime movers are grouped around that prime mover and on not more than two sides of it, and so that all piping connections are short but with ample working space around each piece of apparatus. The operator has then the least possible amount of traveling to do in performing his duties. Such a grouping should give an arrangement whereby the operator or chief engineer can stand in one place and see practically every piece of machinery pertaining to an individual unit.

The boiler house I definitely advise to be a two-story building; the turbine room in my opinion should be a one-story building. It is possible to design a one-story turbine room, and, with the exception of one or two pieces of apparatus, put everything on one floor. The arrangement should also be such that the operators have the least possible amount of climbing to do. Men working an eight-hour shift travel a good many miles in the course of their day's work, even when everything is running normally. If this traveling is all on the level it is much easier on the man, and he can get around very much quicker than if a good deal of it is up and down stairs or up and down ladders. Making the work easier for the operator will result in his doing better work and also taking more interest in his work. Moreover, emergencies will always arise when the operator has a lot of things to do and must do them in the shortest possible time.

Electricity Versus Steam for Railroads.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY HARRY WINFIELD SECOR, E. E.

Electricity, in its application to the requirements of our modern railroads, is being slowly but surely tried out, with the object in view of attaining greater efficiency and higher speed than is now obtainable with the use of steam locomotives. The electrification of a large railroad system is, however, a vast and extremely expensive proposition, and although the scheme of electrifying such a stretch of track as between New York and Chicago, a distance of some 900 miles, has been projected by a number of engineers in the past few years, the railroads have been content to try out these schemes on a more conservative and economical basis.

The application of electric traction to several of the great terminal systems of such railroads as the Pennsylvania and New York Central lines, has served to prove beyond doubt that, when properly utilized, electricity is at once the most readily controlled, efficient and satisfactory source of power extant. The steam engine has served us well for over half a century now, but like other great inventions of mankind, it has about reached its utmost, both in point of operating efficiency, speed limit and general service, and will, in the not far distant future, give preference to a newer and more efficient means of transportation.

To begin with, the steam locomotive of today, which is as highly perfected as scientific skill can make it, does not have a greater overall efficiency than 15 to 20 per cent. This means the relation between the pounds of coal burned and the effective horsepower delivered at the driving wheels while the electric locomotive shows a gross efficiency of 80 to 85 per cent, and more. Of course in considering this last figure, the losses due to the transmission line carrying the current, and also those occurring in the power station generating apparatus must be taken into account. Outside of the flexibility, cleanliness and absence of noise, the operation of an electrified railroad would not present any very remarkable showing as regards operating expenses, if the electric current had to be supplied from steam driven power stations, as the overall working efficiency of such a system does not exceed 10 to 15 per cent, generally.

The numerous advantages of electricity over any other source of energy, for transportation purposes, will become fully utilized in a highly efficient and practical manner, when the vast natural water power resources existing in all parts of the country, are harnessed to the railroad train, through the medium of an electrical generating and distributing system, which has already been successfully applied in Europe and other countries, to lines of considerable length. When a modern hydro-electric power system is employed to supply the electric current, a gross sufficiency of 50 to 60 per cent, is realized, which is quite a contrast with that of steam electric plants.

So much for the operating efficiency of the railroad employing electric traction. Now we will take a look at the speed aspect of the problem, about which there has been evidenced much doubt of late among railroad engineers and in the publications devoted to their interest. The principal argument made is that, "as the electrical engineer promised such wonderful speeds and hair raising performances a few years ago, when electric locomotives were first introduced, why doesn't he show us a little proof. This question is partly answered by the fact that no orders have been given up to this time for an electric locomotive capable of maintaining higher speeds, than those existing at present for steam locomotives. Also, if they were built, the present rolling stock and roadbed could not withstand the terriffic strain imposed by greater train speeds than 100 to 110 miles an hour, which is the present limit.

Another question often hurled at the electrical engineer is "why doesn't the electric locomotive show a greater speed than it does, on trial trips, etc.? The reason why it does not seem to be capable of out-stripping its steam rival, lies in the fact that it was not designed for that purpose. On the contrary, it was designed and built to conform to certain rigid specifications, as supplied by the purchasers, and to date, they have succeeded in fulfilling all the conditions so imposed. As an example, the new electric locomotives supplied to the Pennsylvania Railroad for hauling its trains through the North River tunnels into its New York City terminal, had to be capabale of starting and accelerating a 550 ton train, on a two per cent tunnel grade, and also of hauling a full train at 60 miles per hour or one mile a minute. If the contract had read 120 miles an hour, then the engine being designed for such speeds, would have fulfilled the contract, as it is capable of duplicating any of its steam friend's stunts today, when so designed.

Several years ago, 1903 to be exact, a number of important tests and researches were carried out by a body of engineers in Germany, between the cities of Berlin and Zossen, over a stretch of especially prepared track. The electric potential at the trolley wire was 40,000 volts, 3-phase alternating current, with stepdown transformers on the cars. The front of the cars were equipped with pointed wind shields, to reduce to a minimum the wind resistance, and the maximum speed attained was 130 miles an hour, which became possible without any unreasonable demands of power. To attain speeds of this magnitude with a steam

locomotive, the power necessitated would require it to have such proportions, that a large percentage of the power developed would be consumed in propelling itself, due to the reason that the power demanded at such high speed increases at a higher ratio than the square of the speed, and thus it is certain we shall never see a steam locomotive pulling a train above 130 miles per hour, for this and other reasons.

In speaking of the results obtained from the Berlin-Zossen tests, Dr. Louis Bell, one of the foremost engineers of the day, said, "They show clearly that it is entirely feasible to run electric trains at a speed greatly exceeding that now usual, and this without demanding any unreasonable amount of power." As thousands of horsepower, in the form of electrical energy is now transmitted up to 250 miles it is quite possible to electrify such a line as from New York to Chicago, with but three or four central stations, suitably distributed along the line.

The most important desiderata, in such gigantic undertakings as this, is the tremendous initial cost and the difficulty of changing over the construction while the road is in operation. The way in which these problems will be most likely met and overcome, will be to electrify the individual sections of the road, one after the other, allowing the total expense to be spread over a number of years, at the end of which time, the entire electrification will be complete. Finally, it is not unreasonable to assume, that we of this generation may see the 150 mile an hour train, perhaps a monorail train, when one can lunch in New York, have dinner in Chicago, and breakfast in San Francisco. This is the age of electricity, and its wonders have only begun.

The Seattle N. E. L. A. Convention Program.

When those central station men who have spent a large part of their lives in the industry stop to review its growth and advancement, there must be a certain gratification in possessing the knowledge. Those of us who are younger and have followed the story of the birth and development of the N. E. L. A. as recorded in the pages of the proceedings of that body and listened to the addresses of the association presidents at conventions of the past years, get some idea of the general nature of the industry as it was and how it has become one of the factors in the everyday life of every citizen.

This story is told briefly in the first article of this issue by Mr. Randolph, who by his association with one of the largest of central station systems of today has absorbed the trend of the various features of the industry and given an interesting interpretation of the part which may be expected from the N. E. L. A.

When the convention closed at New York last year there were less than 9,000 members. According to the latest information at this writing the membership now stands at 11,352, an increase which only too plainly points first toward the importance placed upon affiliation with the N. E. L. A. and second toward the rapid strides now taking place in all lines of central station work. The convention this year will have a representation country wide, and should all stations be represented would include more than one thousand. Interest in the convention is now at its highest and the results in work done and plans layed for the future will be eagerly watched for by all who are unable to attend.

The program this year contains something more than 60 items, yet arranged so that all who can confine their desire to enter the discussions in a limited number of fields, may secure all that can be desired from the time spent. The sessions, and subjects to be presented are as follows:

GENERAL SESSIONS.

First—Tuesday, 10 a. m.—1, Welcome to the City; 2, Address of President Gilchrist; 3, Announcements; 4, Report of Committee on Organization of the Industry, H. H. Scott; 5, Report of Secretary, T. C. Martin; 6, Report of Insurance Expert, W. H. Blood, Jr.; 7, Report of Committee on Progress, T. C. Martin; 8, Report of Library Committee, Report of Handbook Committee, Arthur Williams; 9, Report on Question Box, E. A. Edkins; 10, Paper, Expanded Loyalty, Paul Lupke.

Second—Wednesday, 10 a. m.—1, Report of the Rate Research Committee, E. W. Lloyd; 2, Paper, The Desirability as a Central Station Load of Pumping for Municipally Owned Waterworks, Chas. A. Munroe; 3, Paper, Educating Central Station Employees, H. E. Grant. (To be discussed in Company Section meeting, Thursday, p. m.)

Executive Session (12 or 12:30)—1, Action on Report of Public Policy Committee, Arthur Williams; 2, Presentation of Proposed Constitutional Amendments, Frank W. Frueauff; 3, Report of Treasurer, G. H. Harries; 4, Election of Nominating Committee.

Third and Executive Session—Thursday, 2:30 p. m.—1, Paper, Some Uses of Metals, Dr. W. R. Whitney; 2, Report of the Committee on Street Lighting, John W. Lieb; 3, Report of the Committee on Memorials, T. C. Martin; 4, Report of the Committee on Constitutional Amendments, Frank W. Frueauff; 5, Vote on Constitutional Amendments; 6, Report of Nominating Committee; 7, Election of Officers; 8, Adjournment.

TECHNICAL SESSIONS.

First, Tuesday, 2:30 p. m.—1, Report of the Meter Committee, O. J. Bushnell; 2, Paper, Meter Setting, S. D. Sprong; 3, Report of Committee on Grounding Secondaries, W. H. Blood, Jr.; 4, Report of Lamp Committee, F. W. Smith; 4, Report of Committee on Electrical Measurements and Values, Dr. A. E. Kennelly, (to be read with Lamp Report); 5, Paper, Line Voltage, R. E. Campbell.

Second, Wednesday, 10:00 a. m.—1, Report of the Committee on Terminology, W. H. Gardiner, Jr.; 2, Paper, New Current Consuming Devices, F. N. Jewett; 3, Paper, 24-Hour Service in Small Central Stations, Taliaferro Milton; 4, Report of Committee on Overhead Line Construction, Farley Osgood.

Third, Thursday, 10:00 a. m.—1, Report of Committee on Prime Movers, I. E. Moultrop; 2, Report of Committee on Electrical Apparatus, L. L. Elden; 3, Report of Committee on Underground Construction, W. L. Abbott; 4, Paper, Care and Operation of Transformers, W. M. McConahey.

POWER TRANSMISSION SESSIONS.

First, Tuesday, 8:30 p. m.—1, Address of Chairman, Henry L. Doherty; 2, Report, The Use of Electricity for Irrigation and Agricultural Purposes, C. H. Williams, (illustrated by lantern slides and motion pictures).

Second, Wednesday, 2:30 p. m.—1, Paper, Work and Publications of the U. S. Government Relating to Hydro-Electric Development, J. S. Hoyt; 2, Report of Power Transmission Committee of the Association, J. R. McKee; 3, Report of Committee on Power Transmission Progress, T. C. Martin; 4, Paper, Switchboard Practice for High-Tension Power Transmission, Stephen Q. Hayes.

Third, Thursday, 2:30 p. m.—1, Report of Committee on Receiving Apparatus for Use on Transmission Lines, F. B. H. Paine; 2, Paper, Corona on High-Tension Lines, G. Faccioli; 3, Report of Committee on Protection from Lightning and Other Static Disturbances—S. D. Sprong; 4—Topical Discussions (time permitting).

COMMERCIAL SESSIONS.

First, Tuesday, 2:30 p. m.—1, Address of Chairman of Section, H. J. Gille; 2, Address, Commercial Development of the Electrical Industry, W. W. Freeman; 3, Report of Committee on Membership, George Williams; 4, Report of Committee on Steam Heating, S. M. Bushnell; 5, Report of Committee on Electric Refrigeration and Ventilation, John Meyer.

Second, Tuesday, 8:30 p. m.—1, Report of Committee on Residence Business, J. F. Becker; 2, Report of Committee on Industrial and Commercial Lighting, E. H. Beil; 3, Report of Committee on Competitive Illuminants, F. H. Golding; 4, Report of Committee on Electric Advertising and Decorative Street Lighting—W. H. Hodge.

Third, Wednesday, 2:30 p. m.—1, Report on Electric Vehicles, L. R. Wallis; 2, Report, Electricity in Rural Districts, J. G. Learned; 3, Paper, A Plan for Increasing Power Load, H. W. Cope; 4, Report, Selling Current to Larger Power Users, Joseph Lukes.

Fourth, Thursday, 10:00 a. m.—1, Report of Committee on Cost of Commercial Department Work, E. L. Callahan; 2, Report of Committee on Contract Order Routine, T. I. Jones; 3, Report of the Committee on the Commercial Index, E. L. Callahan; 4, Paper, Ozonators and Their Exploitation by the Central Station, M. O. Troy.

ACCOUNTING SESSIONS.

First, Tuesday, 2:30 p. m.—1, Report of Committee on Uniform Accounting, E. J. Bowers; 2, Paper, Incandescent Lamp Accounting of the New York Edison Co., W. H. Bogart; 3, Paper, Handling and Accounting for Scrap Materials, Chas. E. Bowden; 4, Paper, General Filing Systems, R. H. Williams.

Second, Wednesday, 10:00 a. m.—1, Paper, Proper Accounting for the Salẻ of Electric Devices, L. M. Wallace; 2, Paper, Scientific Management of an Accounting Department, Franklin Heydecke; 3, Paper, Central Station Motor Vehicle Costs and Their Distribution to Accounts Benefitted—E. C. Scobell.

Third, Wednesday, 2:30 p. m.—1, Paper, Regulated Electric Light Accounting, H. M. Edwards; 2, Paper, Progresś Made in the Uses of the Tabulating Machine, Mr. Schmidt, Jr.

PUBLIC POLICY SESSION.

Wednesday, 8:30 p. m.—1, Musical Program; 2, Reading of Report of Public Policy Committee, Arthur Williams; 3, Report of the Medical Commission of Resuscitation from Shock, W. C. L. Eglin; 4, Lecture, Electrification of the Panama Canal (illustrated by lantern slides).

COMPANY SECTIONS SESSION.

Thursday, 3:00 p. m.—1, Report of Committee on Award of Doherty Gold Medal, W. W. Freeman; 2, Discussion of Grant Paper; 3, The Proposed Company Section Lecture Bureau, T. C. Martin; 4, Experience Meeting as to Company Section Work.

Sales Agents' Convention of Fort Wayne Electric Works.

A few weeks ago the Fort Wayne Electric Works of the General Electric Company held a convention of sales agents at the home office at Fort Wayne, Ind. There were about seventy-five of the salesmen, including the managers of all the district offices of the company, present at the various sessions, which were held in the assembly room of the new factory building No. 17, now nearing completion.

The business of the convention was given over largely to illustrated lectures and discussions covering the commercial, and as well, the manufacturing side of all the company's product. The sessions, while long, lasting from 9 a. m. to 6 p. m., with only a short hour for lunch, were very interesting and unquestionably beneficial to all the agents who were privileged to attend. On Wednesday evening of the convention there was held at the Elks' Temple a banquet and Rejuvenation of the Sons of Jove, at which forty candidates were initiated. The convention closed with an elaborate banquet at which covers were placed for one hundred and twelve guests.

Fort Wayne Sales Agents at Convention.

In the illustration, reading from left to right. Top Row.—L. A. Carr, salesman; W. V. Orr, mgr. Cleveland Office; L. M. Page, salesman; C. A. Thomas, salesman; O. F. Allen, salesman; E. H. Porter, salesman; F. E. Ganter, salesman; F. S. Bellaire, salesman; E. H. Merrithew, salesman; C. R. Metchear, salesman; A. P. Dunn, salesman; G. B. Edgar, salesman. Third Row.—H. W. Miller, salesman; W. B. Crabtree, mgr. Milwaukee office; A. H. Savage, mgr. St. Paul office; J. C. Moulton, salesman; M. A. Buehler, salesman; E. D. McKellar, mgr. New Orleans office; A. J. Francis, salesman; Gordon Fox, salesman; C. A. Woolsey, salesman; J. B. Crankshaw, salesman; F. L. Reynolds, salesman. Second Row.—J. E. Hall, salesman; G. I. Kinney, mgr. San Francisco office; A. H. Boyd, mgr. Philadelphia office; J. C. Lott, mgr. New York office; T. J. Ryan, mgr. Cincinnati office; S. A. Hobson, mgr. St. Louis office; A. L. Pond, mgr. Chicago office; H. W. Smith, mgr. Boston office; W. K. Eicher, principal soliciting agent in Michigan; W. R. Hendrey, mgr. Seattle office. First Row.—J. O. Spear, Jr., mgr. Charlotte office; C. H. Hickman, salesman; M. B. Beattie, salesman; H. G. Fetherling, salesman; L. J. Osborn, salesman; H. Bozarth, salesman; S. H. Smith, Jr., mgr. Atlanta office; A. Penn, salesman; C. E. Roesch, Jr., salesman.

Investigations in Electrolysis.

During the past year an extensive investigation into the subject of electrolysis has been in progress by the Bureau of Standards, Washington, D. C. This subject is one of great practical importance, not only to engineering interests, but to municipalities and the general public. Damage to water and gas pipes and other underground structures by stray electric currents has long been a source of serious trouble, and although much work has been done by private interests with the view of mitigating the evil a great deal of investigational work remains to be done bẻfore remedial measures can be applied with satisfactory precision. Also during the last few years a great deal of attention has been drawn to the possibility of damage to reinforced concrete structures, due to stray currents, and much alarm has been created in some quarters lest great damage to buildings, bridges, etc., may result from this cause. Although the possibility of damage of this sort had been established, little was known before this investigation was started in regard to the extent of the damage that had occurred, the conditions under which trouble might be expected, or the best method of mitigating the evil. Information on the subject can be obtained from the Bureau.

Municipal Ownership Defeated at South Framingham, Mass.

A six years' municipal ownership campaign came to an end at South Framingham, Mass., at a town meeting in March, by the casting of a vote of 403 for and 510 against the establishment of a plant for street lighting and other service. The town has for some time been supplied with electricity by the Edison Electric Illuminating Company of Boston, and it is estimated that about $6,000 worth of discounts on the street lighting service have been lost by the failure of the authorities to enter into a long-term agreement with the company. The late agitation dates back to 1906, and was characterized by extended work in favor of municipal ownership by a special lighting committee appointed by the town two years ago. The committee made a final effort to secure the passage of a municipal ownership vote about the middle of March, contending that if an affirmative vote was passed by the two-thirds majority necessary, the company would be obliged to submit to the town its intentions regarding the sale of its plant in the event of the passage of a final vote at a later election. It was also urged that the company would have to submit a statement of the value of its property. A feature of the situation was an unsuccessful attempt to change the Massachusetts municipal ownership law, which places safeguards around the existing plants by making hasty decisions in favor of municipal ownership impossible. The propaganda was defeated by a comfortable majority, and immediately after the vote a 10-year street lighting contract was authorized. During the agitation the neighboring towns of Medway, Holliston and Sherburn each entered into 10-year street lighting contracts with the company, and the municipal ownership issue is now dead in the South Framingham district.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Our Plans for Remainder of the Year.

In order that readers of this department may know what topics have been selected for future discussion and be able to plan their contributions or offer suggestions, we give herewith a tentative outline of the subjects for the remainder of the year, which will be followed as closely as possible. In presenting this outline we desire to say further that while the order in which the topics are to be presented will not likely be changed, yet the greater or less importance of these subjects as evidenced by the amount of matter contributed, may cause a shift in the general position and throw them to a different month than originally planned.

Next month we will take up the question of rates and services, particularly as regards new business. Write and tell us what rates you have found attractive to the classes of business making up your station load.

In the August issue we will discuss the general functions and policies of the commercial department, and also describe some summer campaigns for small current consuming devices.

In the next number we will take up the organization of the commercial department more in detail, as to personnel, records and methods of work, and also tell about the best ways to approach and get business from municipalities, school boards, and other public bodies. We especially desire a general participation in this number, as it is one in which nearly every one can take some part. We would particularly request lighting solicitors to write us brief descriptions of their methods, anecdotes telling how certain business was secured and any other information bearing on the subject.

The next subject, which if the schedule can be maintained will be discussed in the annual October lighting number. We will take up a study of fall business, both residential, commercial and power, including ways and means for meeting isolated plant competition. Write and tell us how you did it. Also tell us how you attracted industries to your town and secured their business on your lines.

Following this discussion we plan to take up the means of aiding direct solicitation. Under this head would come display rooms, advertising, co-operative methods, and other things to boom business. This should prove a live subject. We also desire to make a study of how complaints, delinquencies, etc., should be handled.

In the December number we will take up Christmas business schemes. What propositions can you make to interest dealers and others in electrical holiday goods?

These are our suggestions for a program, but we trust that those who have other topics or suggestions will not hesitate to send them in even if there is no particular reference made here to the subjects proposed. It will be possible to care for such in a satisfactory way, if not in connection with some other subjects, in a separate issue. In any case we want your suggestions, comments and criticisms.

We desire at this time to call the attention of those companies now organizing or planning to organize a new business department or start a campaign, to the assistance SOUTHERN ELECTRICIAN offers. We are prepared to submit plans or suggestions, furnish cost data and complete details, for any campaign or layout an entire campaign, giving all necessary information, advertising, etc., to carry it to completion. Mr. A. G. Rakestraw, associate editor of SOUTHERN ELECTRICIAN, will have entire charge of this feature of the work. His experience as an electrical engineer has included the engineering and commercial sides of central station work with both large and small properties. He has to his credit the organization and management of financially successful commercial departments, thus furnishing readers of this publication the opportunity of securing first hand information and expert advice on any new business subjects which may be of interest at any time. Address your communications to Editor New Business Department.

Our discussion in this issue is the proper relationship with the public.

R. V. Scudder, Vice-President and General Manager, The Wesco Supply Company, St. Louis, Mo., on Trade Relationship Discussion in April Issue.

I have read with a great deal of interest the discussion in your April number on the trade relationship between manufacturers, central stations and dealers, and it seems to me that the subject has been covered pretty well in those papers, but when you boil the question down it must be solved like any other question, and that is by good common sense and business logic. From the standpoint of the manufacturer I believe that every manufacturer will admit that it is best for his interests that the price on his commodity to the consumer be maintained at a point that will provide an adequate margin of profit for the handling of the commodity through the natural channels that it will have to pass if the sale of the commodity reaches any great proportions. I do not think any manufacturer will question this statement, so it would seem that this disposes of the question from the manufacturer's standpoint.

Now as regards the question of the relationship between the central station, the jobber, the dealer and the contractor, every one must admit the necessity of these various branches in the electrical field, and admitting that necessity, we must also admit the importance to the industry that in the conduct of each of the lines, due consideration be given to the welfare of the allied lines or channels of trade in the same industry, as the success of each of the lines lends to the success of the others. It has been my observation that the most successful central stations desire and solicit the co-operation of the contractor, the dealer and the jobber operating in their city, and certainly they could not secure their co-operation if they were conducting their business along the lines of selling electrical merchandise at cost or at too small a margin of profit to justify the contractor or dealer in handling it.

It is a question whether it is more desirable for a central station to confine itself solely to the sale of current (if they desire, maintaining a show room to exhibit the various devices), and let the contractors and dealers handle all the sales of the devices, or for the central station to also engage in the selling of the goods, and the answer to this question by the central station should be governed in each instance by the character and ability of the dealers and contractors in the town in which the central station is located. Under no circumstances is the sale of appliances at cost or at an inadequate profit justified.

Admitting the correctness of the central station engaging in the sale of the devices if they so elect, if they sell without an adequate profit it will result in either driving the dealer to handle an inferior device which he can buy at a lower price and thus meet the central station's competition, or drive him out of the business altogether. In the first event, the article sold by the dealer fails to give the consumer satisfactory results with the consequences that the consumer condemns electrical devices generally, and it reacts detrimentally on the use of current consuming devices as a whole. In the second event, when the central station drives the contractor or dealer out of business, they have lost the assistance of a creator of business who is willing to work for their interests without expense to them.

If the same central station in selling the devices, maintained an adequate margin of profit to cover the cost of selling, with a fair return on the investment, it would make for better conditions all around, because the business being profitable, the contractor and dealer would prepare himself to properly display the goods, promote their use, and push their sale. You would find properly appointed sales rooms throughout that town in very short order, with the result that the central station would soon have an enthusiastic lot of solicitors working for their benefit without expense to them, to say nothing of having obtained a profit on the devices they sold themselves, instead of a loss from that source, as selling at cost or an adequate profit invariably means a loss that has to be made up from some other source. The argument advanced that the lowering of the price twenty or twenty-five per cent increases the sale of electrical devices, I believe to be incorrect, as it has been my observation that the best article, and the public is prone to judge the quality of an article by the price, meets with the largest sale providing the price is not prohibitively higher than the lower priced article, and as an example supporting this contention, I give the following:

A central station recently inserted an advertisement in a daily paper like this: (I will use fictitious names for the irons):

Sale of Irons.

Jones' Iron, regular price........$5.00;	Sale price, $3.75
Smith's Iron, regular price...... 4.75;	Sale price, 3.25
Sad Iron, regular price.......... 4.00;	Sale price, 3.00
Johnson's Iron, regular price..... 5.00;	Sale price, 5.00

The actual result from that advertisement was the sale of ten of Johnson's Irons at the full price of $5.00 each to one of any of the others at the cut prices.

Co-operation assisted by frequent meetings and discussions of local conditions between the central station, the dealers and the contractors doing business in the town and the conduct of the business on sound business principles, one essential of which is selling goods at a fair margin of profit, will promote the interests of the central station as well as the contractors and dealers. Just as I have written these remarks, there has come to my notice an issue of a central station publication, on the first page of which there is an article under the heading, "Reforming the Appliance Policy," which article goes on to explain how the Brooklyn Edison Company made a seventy-one per cent increase in appliance profits through adopting of retail merchandizing methods.

H. J. Mauger, of General Electric Company, on Maintenance of Retail Prices and Co-operation Between Central Stations and Dealers.

The General Electric Company protects its central station and dealer customers by publishing retail prices in all their literature and in maintaining these prices whenever a retail sale is made. For the past two years the company has been urging its central station customers to sell heating devices at a fair profit in order to give their dealer competitors a chance to sell the same goods, and do it profitably. This is particularly true of those devices in which the initial stage of introduction, and possibly introductory prices, are past, and where a market has been created, of which the dealer can take advantage.

The business of the General Electric Company in heating devices is principally with central stations, and there is no doubt that these agencies can best do the missionary work and have a continuous incentive in the possible sale of current in promoting the exploitation of current consuming devices. Therefore, the central station should develop every possible sales outlet in the community which would tend to increase the total use of current consuming devices. There is no question that it would be to the advantage of the central station to have every contractor and dealer boosting the business. It is not to be expected, however, that a central station will agree to more than 25 or 30 per cent. profit, and that the dealer must be satisfied with this in view of the increased business resulting to him through co-operation with the central station. In a paper read by the writer on "The Introduction of Current Consuming Devices," before the Indiana Electrict Light Association in 1910, he urged this co-operation on the following basis: "A most important step, therefore, is to arrange a basis of co-operation with dealers and electrical contractors. Every possible outlet for the sale of current consuming devices should be cultivated in this co-operative arrangement. There are two practical means for effecting this co-operation among dealers. First: The central station can act as purchaser for all the others, securing for them the benefit of buying in large quantities; and assume the financing of the business, perhaps placing stocks of goods on consignment to the dealers. The other way is to form a pool for combining purchases, each participant sharing in equal responsibility. The current consuming devices under this arrangement should not be sold at cost, but a profit of 20 to 25 per cent. charged to compensate the dealers, and such price maintained by all. The profit can also be used to good purpose by the new business department itself. The lower price secured by combined purchases in quantity partly offsets this increase in the retail price."

There is no danger to be expected from oil used in transformers. The danger, if any, has been attributed to the explosive mixture formed by the vapor of the solvent of the insulating varnish and air.

The Central Station and the Public.

Within the past few years a marked change has taken place in the mutual attitude of the public and those corporations that serve them, including the steam railway, electric railway, telephone, electric light, water and gas companies. On the part of the public there has been a feeling of mixed hostility and suspicion, and this feeling has expressed itself in demands for better treatment, indicated by the appointment of public service commissions, rate regulations, municipal ownership agitation, and other things, many of which are reasonable, and unreasonable.

As a result of all this, public service corporations are interesting themselves in matters of public policy as never before, partly, no doubt, from motives of business policy and self-preservation, and partly, let us hope, from a growing realization of the fact that such corporations owe certain duties to the public as public servants.

The editor of this department feels compelled to say, even though it may be an unpleasant truth, that much of the present suspicion with which the public service corporations are regarded is a direct result of the "public be damned" policy which has been too often followed in the past. Public sentiment is slow in taking form, yet the cumulative effect of numerous small grievances, real or fancied, will gradually crystallize into a well defined unfavorable sentiment. Whether or not this unwill may be the result of past, rather than present conditions, it will require a long period of good treatment to gradually restore normal relations.

Why is the question of public relations paramount? Principally, as summed up by W. H. Hodge, of the Byllesby interests, in what follows: "Public utilities are in reality the most democratic of commercial institutions. Patrons are of all conditions and of all classes in the human scale. They are served with more uniformity and less discrimination by gas, street railway, electric, telephone and water companies than by any other business." It therefore follows that public utilities depend, as do no other class of industries, on public favor. Further, proper public relations are important because of the monopolistic feature of public service. That such service can be most economically conducted without competition is an undisputed fact, that unregulated monopoly can be, and too often is abused, is too evident to need proof, and that the continued abuse of monopoly is bound to result in reasonable or unreasonable regulation and restriction, or in expensive competition, is a matter of history. In view of these facts, a careful study of public relations, with the interests of the public at heart, is not only morally obligatory upon public service corporations, but is good business.

What you may ask can be done to further such investigation, and to promote proper public relations? First, make an impartial study of the conditions, without seeking to evade responsibility. Use every avenue of information which will enable you to accurately determine public sentiment. Whenever anything is discovered that has caused or will cause trouble remedy it, carefully and patiently, remembering that as it takes a good while for complaints to become acute, so that it will take a good while to remove their effect. To this end the manager of every station should personally, or through a responsible representative, logically the manager of the commercial department, arrange to take care of every complaint that comes in. Under no circumstances should adjustments be left to the general office force. Outside men, such as meter readers, collectors, linemen, etc., should be required to report the slightest dissatisfaction coming to their attention.

Second, the organization as a whole must have a proper conception of the obligation of the corporation as a public servant. As long as the manager of a central station takes the attitude, that on account of financial interests involved, he has no right to take the public into his confidence and permits this spirit to prevail in his organization, just that surely is he fostering a sentiment that in the course of time will develop into active public hostility. No corporation will ever advance in public esteem until every officer and every man that comes into contact with the public maintains an unselfish and public-spirited attitude. These two things taken care of, the rest is a matter of detail.

The matter of publicity, courtesy, and those details which go to make up the difference between unsatisfactory and satisfactory service, all claim attention. The often unreasonable agitation for rate reduction can largely be prevented by publicity in regard to the earnings and disbursements of the company. It is very easy and natural for a customer with a high bill to say that the rates are excessive, even if he has no knowledge that they are, but if the company has shown by its published statements that the return on its investment is within reason, such charges cannot be supported among intelligent members of the community, and will become of no effect. If, however, the policy of the company is and has been secrecy, such statements will be believed, and will add just that much to the weight of public sentiment.

Courtesy, that potent but neglected factor in moulding public opinion, is now being given more attention. While business houses and other enterprises have long recognized the value of courtesy in promoting good will, public utilities have been slow, as a rule, in enforcing it. Some central stations that insist on it from their solicitors neglect to require it from their clerks, collectors, linemen and other employes. Those who have to go out and get the business and who know how hard it is to secure it, have found by experience what harm even a short answer, unintentional, perhaps, may do to the interest of the company.

There are many slight attentions which every central station manager may give his customers at small expense, which will yield large returns in good will. It may be time spent in advising a customer who has some perplexing problem, it may be a trip to replace a fuse at some unseasonable hour, or it may be some special service in case of sickness, or a few extra lamps at the last moment for the house party, colored, perhaps, for decorative effect, or a streamer put up free or at nominal cost for some outdoor social event. If the manager is on the lookout for opportunities to oblige the customer he will find many of them, and can produce favorable impressions that cannot be obtained otherwise at many times the expense.

It is hardly necessary to say that the commercial department is the one most important factor in promoting harmonious public relations. Composed of commercial men, trained in salesmanship, it will, unless very badly handled, aid wonderfully in this work. A cheerful, courteous solicitor, who is not over burdened with territory, and who can take time to get acquainted with his district as he should, can do more to raise the company in public estimation than any other one thing. A. G. RAKESTRAW.

Opinions of New Business Men.

Errett L. Callahan, Manager, New Business Department, H. M. Byllesby & Company, on Benefits and Relations Between the Public and Central Stations as Represented by Rates and Profits.

The manager of any progressive business concern of to-day must be wide awake and optimistic if he is to make a great success of his work. Great success, however, demands many other things besides these qualifications, for it goes without saying that good judgment, tact and horse sense are essentials. Particularly is this true in conducting the business end of a public utility company.

The problem of merchandising electric service is no more difficult than to sell any other kind of merchandise backed by a reliable house, and which is in itself a reputable product. The most important thing is ability to deliver the goods. The second most important thing is the necessity of establishing and advertising a liberal and just policy; third, it is necessary to fix a popular price consistent with the service rendered. On this basis go after all business, all the time, everywhere, within the widest field which can be served.

Many will ask, "is there any such thing as popular rates?" I would reply that there are both popular rates and popular utility companies, despite skepticism to the contrary. The price for the service should be as low as possible, consistent with sound management and to enable the best service. Service means everything to the user of electric energy, whether that use be for illumination or for power in turning factory wheels.

Success to-day in the central station business is achieved by widening and developing the market and reducing the unit cost of service. In many cities throughout the country electric light and power companies have operated for 18 or 20 years, and gladly connected to their service wires all business which came their way. Some of them even spent several hundred dollars a year letting the people know they were still in business, using a 3 by 3 inch card in an obscure corner of the local newspaper. Although rates were high, the volume of business was often insufficient to declare a small dividend. In most cases the thing that was wrong was found to be the lack of the right commercial policy and the lack of a sales department. Managers began to see the disadvantages of having connected to their lines but one residence out of every ten; one commercial customer for every five possibilities and one factory for each twenty industrial institutions in the city. They reflected that nearly every other business house had salesmen going about the streets and traveling through the country distributing their product.

Coincident with the general movement toward the establishment of new business or commercial departments, came recognition of the vital necessity of reducing rates and making the price for electricity within the means of the greatest possible number of people—in the case of industries, sufficiently low to compete successfully with other forms of power. Again and again these policies have demonstrated their merit in building up the business to a profitable stage and at the same time improving public relations. It is business. It is a square deal to the public. It spells success for the central station.

The American people want service and are willing to pay for it. On the whole the public is willing to have the public utility companies lead in progressive movements for the mutual good of the communities and themselves, and it is this sort of recognition that is going to broaden the central station field in the right way in the future.

H. G. Scott, Commercial Engineer of Central Georgia Transmission Co., Atlanta, Ga., on Why is Public Sentiment the Most Powerful Influence in a Public Utilitys Relations With a Community?

The writer would answer this question by saying that the sentiment of a community towards a public utility corporation is the most powerful factor operating in favor of, or against, a dividend. A central station sells to all classes of people a commodity, the measurement of which is not understood by its customers. They are operating under an inherent belief on the part of the public that its managers, to say the least, are not examples of the man that Diogenes was looking for. It is necessary for the central station to come in contact with all the political factions of a community; it has of necessity to deal with the various councils which are elected from time to time; the public utility commission takes a hand in directing its operation and the superintendent of electrical affairs must be consulted. The various electrical dealers when they are not responsible are the cause of infinite trouble, and the manufacturers of consuming devices are constantly bringing out more efficient apparatus which tends to cut the central station revenue from year to year for the same work done. And last, but not least, the central station has to go before the court and jury and answer for the unavoidable accidents which so often happen.

The path of the central station manager is not rose strewn under the best conditions, but it is almost impassable if, in meeting these various conditions, he has to combat an adverse public sentiment. In selling current to a consumer the first requisite is to show the consumer that the charge is reasonable, and not arbitrarily fixed at the highest price the central station believes that the consumer will pay for it. Another thing is to show that the central station has at heart the interest of its customers, that it believes in the future of the community in which it is operating, and that it is doing everything that it can legitimately do to further the interest of the community as a whole. The central station must realize that it asks a great many favors of the public at large, it blockades the streets, it tears up the pavements, it inconveniences the people fronting on the street where the construction is taking place, its service is, under certain conditions, interrupted, and various other things happen that put it in a position where it must ask the indulgence of the public. The people as a whole are perfectly willing to grant this, and to do everything they can to assist the utility company where they are convinced that the central station is doing these things. If they are satisfied on this point they are perfectly willing to listen when solicitors call.

They can go into court and have their cause thoroughly tried, and not have the jury "soak" them with heavy damages simply because they are one of the soulless corporations. They can secure consideration from the councils, and get their co-operation, without having to meddle in political campaigns. In fact, to sum up, we would say that,

First: With a favorable public sentiment the actual cost of operation of the executive and constructive departments is materially decreased.

Second: That the revenue derived from the community will increase yearly.

Third: That a contingent or emergency fund to take care of the difficulties that are to be met, will be a great deal smaller than with an unfavorable public sentiment, and, last, but by no means least: The competition which in the electric business is always probable, will certainly not be feared by the company to whom public sentiment is favorable. It does not entirely forestall it, and there is room for argument as to whether such a company would want to forestall it, as it will clearly show that the central station enjoying this favorable opinion on the part of the public was selling current at a fair and reasonable figure, and on good terms. It would greatly advance the interest of the community, and the company, by showing to every one that here was a city co-operating with its public service company, and both deriving the greatest possible benefit from its operation.

The prospects of such a company would be such that the stock would become non-speculative, as it would have a great value as an investment proposition, and as an investment, it would have a great many of its customers as stockholders, and this is what we all want.

The writer is in hearty accord with the statement made by Mr. S. E. Doane, chief engineer, of the National Electric Lamp Association, to-wit:

"The rate established by a public service corporation should be more carefully considered than its generation plant, its distribution system or any other piece of construction or engnieering work. It is the one bond between the property it owns and the public it serves; and it should be strong, equitable and elastic; it should ring true; it should be the best advertisement of the company and its largest equity. If I were a central station man, I would rather have a good rate system, well established and understood by the people who have been educated to its equity in preference to almost any kind of franchise. In fact, I think no franchise can compare in value with the firmly established good will a company receives through its fair dealings with the public as expressed in its rate schedules."

The company with which the writer is connected believes that the most powerful factor in favor of ultimate success is to have a friendly public sentiment, and expects to demonstrate, by its fair dealing and equitable charges, that it is entitled to it.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

CANDLE POWER AT TIP AND ON HORIZONTAL FOR A LAMP.

Editor Southern Electrician:

(298). What features about the design of carbon and tungsten lamps determine the candle power at tip and on the horizontal? Has the shape of glass bulb any effect? How must a filament be changed to increase candle power on the horizontal and decrease it at the tip? About what is the proportion in a well designed lamp? R. W. S.

OPERATION OF HYDRO-ELECTRIC PLANTS.

Editor Southern Electrician:

(299) I now have a 150 Kva. generator operated from a water wheel and carrying a small induction motor load and lighting. It is possible to secure considerable more motor load and if such is done, it will require more generator capacity. It is not possible with the present hydraulic arrangements at our present power site to install another machine without considerable expense in constructing a new dam. There is an excellent opportunity to make use of a good power site about 300 yards up stream where a building now stands and could be used to house the generator. What I desire to know is this: Can an induction generator be installed at the up stream point and a synchronous motor be installed on the line when the new motor load is added, operating as a motor and also furnishing leading current for the induction generator. I understand that the induction generator, which is no more than an induction motor driven above synchronous speed, will operate under such conditions with practically no attention and does not require a turbine governor. I would like to hear from those who have used such an arrangement or think it would be satisfactory. My only object in considering this scheme is to make additions at least cost. Kindly comment from this standpoint. G. B.

COST OF RESIDENCE WIRING.

Editor Southern Electrician:

(300) What may be taken as the cost per outlet for wiring a two-story eight room house (already erected not wired) with a ceiling and side wall outlet in each room, two ceiling outlets for the halls and one outlet each for four closets, a bathroom and two verandas. Give wiring cost per outlet for the rooms, with an additional charge for closet lights and also for baseboard outlets. Give cost of switch outlets for three rooms. Also separate cost of conduit wire and labor for the total work of 25 outlets. No fixtures to be considered other than switches and meter connections. H. T. R.

INSPECTION AND TESTS OF LIGHTNING ARRESTERS.

Editor Southern Electrician:

(301) I would like to know the necessary inspection and tests now regarded advisable for both indoor and outdoor lightning arresters. State for different types. S. C. S.

FACTORS LIMITING TRANSMISSION VOLTAGE.

Editor Southern Electrician:

(302) What factors limit the voltage that can be used

on long distance transmission lines? I understand that the distance should be kept such that the time of transmission of an instantaneous value from generating station to receiving end should not be be more than one-quarter of a cycle. If this is true kindly explain reasons. G. W. C.

HOW DO ELECTROLYTIC AND MOTOR TYPES OF RECORDING WATTMETERS COMPARE?

Editor Southern Electrician:

(303) I would like the opinion of your readers on electric meters. We have in our town a moving picture theatre in which is installed a 50 ampere Duncan wattmeter for the machine and a Bastian recording wattmeter for the house lights. What I desire is an unbiased opinion of this Bastian meter from those who have used it or others similar in principle. It is quite simple and is guaranteed to be as accurate on .001 ampere as on full load.

The instrument is composed of a long round glass tube into which is poured water and caustic soda with lime all dissolved. The electrodes are then immersed in it, the meter thus operating on the electrolytic principle. The decomposition of the liquid is in proportion to the amount of current passing through the electrolyte, the instrument being connected in series with the line. The reading is taken from a scale on the side of the tube. I would like some one to criticise this meter, comparing it with the motor type meters, and advising as to whether or not it is extensively used. R. B. S.

WILL OIL INJURE MOTOR WINDINGS?

Editor Southern Electrician:

(304) I have an a. c. motor in the meal room of a cotton seed oil mill where it is covered with meal all of the time. Is there any serious damage that can be done to the motor if allowed to operate under these conditions? R. C. W.

Life and Candle Power of Tungsten vs. Carbon Lamps, Ans. Ques. No. 275.

Editor Southern Electrician:

The subject of variation of candle power with voltage variation is a vital one from an economical standpoint, both to customer and central station. With a wide fluctuation of voltage on a system more lamps are burned out and a fewer average number are in service. The variation in candle power is most noticeable on carbon lamps, and both carbon and tungsten have a longer life when operated on a system where the voltage is steady and the lamp suited to the pressure. From Fig. 1 it is seen that an increase of voltage over normal of only 5 per cent increases the candle power of a carbon lamp over 30 per cent, and that of a tungsten lamp about 20 per cent.

The variation of candle power with hours of burning are shown in Figs. 2 and 3. The former shows the variation for a tungsten lamp the latter for a carbon. The candle power of the tungsten lamp slowly decreases during life to about 90 per cent of rated value, having a much higher average value than carbon lamp, as is seen by comparison of the curves.

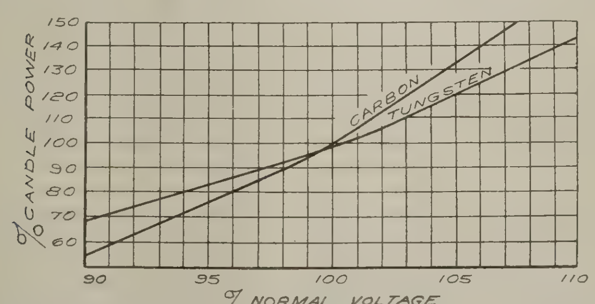


FIG. 1. VARIATION OF CANDLE POWER WITH VOLTAGE.

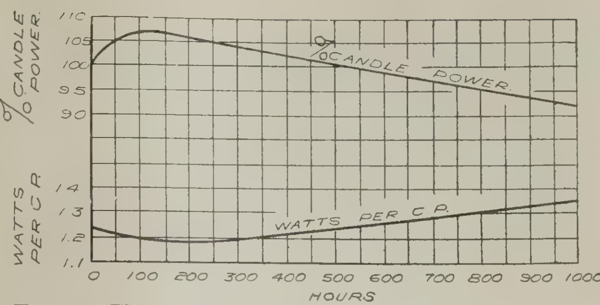


FIG. 2. VARIATION OF CANDLE POWER WITH LIFE OF TUNGSTEN LAMP.

The useful life of carbon lamps is reached when the horizontal candle power has fallen to 80 per cent of its initial or rated value. However the lamp may continue to burn to one thousand or more hours, but the candle power will diminish accordingly and it will be far more economical to replace it with a new lamp before the life has reached the above value, for the reason that the wattage during life remains practically constant and the cost per candle power will therefore increase. Referring to the candle power curve in Fig. 3, it is at once seen that after the lamp has burned 450 hours, the candle power has been reduced 20 per cent, the total wattage, however, remaining almost constant, decreasing only about 4 per cent.

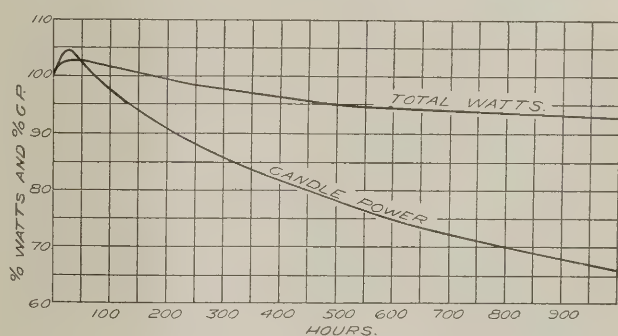


FIG. 3. VARIATION OF CANDLE POWER WITH LIFE OF CARBON LAMP.

By way of illustration, assume a 16 candle power lamp burning about 1,000 hours and consuming 60 watts, the wattage remaining constant throughout its life. Now suppose the cost of burning for the first hour to be X cents and the lamp emitting its initial candle power, at the 450th hour the cost of burning is still X cents for this hour, but the lamp only emits 80 per cent of its rated candle power or 12.8 candle power; at the 1,000th hour the cost remains X cents for this particular period, but the candle power has diminished 33 per cent or 10.72 candle power. The cost per candle power, it is seen, increases with the increase in life, because the watts per candle increases rapidly.

With the tungsten lamp this is not true, for the watts per candle increase is small during life. From Fig. 2 it is seen that at 1,000 burning hours the watts consumption of the tungsten lamp is very nearly the same as at 500 hours burning. The curves presented with this letter are

taken from Mr. Rakestraw's article in the September, 1911, issue of Southern Electrician, and further interesting material is given by him in that number. H. F. Boyle.

Frequency of Systems, Ans. Ques. No. 291.

Editor Southern Electrician:

High frequency systems are in general better for incandescent lighting than low because the transformers cost less and there is less tendency towards flickering in the lamps. On very low frequency systems a thin filament lamp will cool to such an extent during the time the current is near zero that there is a very perceptible flickering of the light. If a lamp have a large, stout filament, such as the low voltage ones have, there will be an increased heat storage capacity because of the increased ratio of volume to surface, and therefore less tendency to flicker.

Low frequency systems are better than high for machines because power factors of motors are better, and it is much easier to design rotary converters for low frequency. There is much to be said in favor of and against each system, and the prevailing practice seems to favor the adoption of two frequencies, such as 25 and 60. In the opinion of the writer it would be much better to adopt two frequencies, the higher one of which is just twice the lower. Then we could use motor generator sets of several speeds, such as 1800, 900, 450, etc. (for a 30-60 cycle system), whereas at present where we use 25 and 60, the smallest number of poles that we can use is 10 on the 25 cycle machine and 24 on the 60 cycle one, which gives a maximum speed of 300 Rpm.

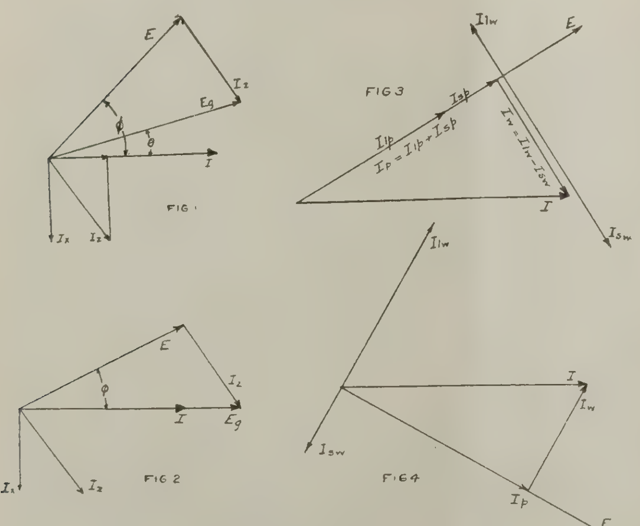
Power Factor of Synchronous Motor, Ans. Ques. No. 293.

The power factor, as its name implies, is a factor by which the volt amperes is multiplied in order to get the true power in watts. Let the power factor be F, then, watts = EIF and F = W/EI. If P is the number of kilowatts and E the voltage in kilovolts, then, P = EIF and F = P/EI as before.

It is evidently impossible for the power to be greater than the kilovolt amperes so that F cannot be greater than unity, and is usually less, about .50 to .75. Therefore, the figures given in the question are impossible, since 250 is greater than 3.6×39. The following figures will illustrate a possible case.

E = 3600 volts or 3.6 kilovolts.

I = 50 amperes.



Relations in Synchronous Motor Circuit.

P = 150 Kw.

$F = 150/3.6 \times 50 = .833$.

The power factor is then .833 and the angle of lag (or lead) is 33° and 30′ because the cosine of 33° 30′ is .833. For three phase systems, $P = EIF\sqrt{3}$ where E is line voltage.

In Fig. 1 let I = line current, E = line voltage and Eg = generator voltage = vector sum of line voltage and voltage consumed by line impedance. The Emf. consumed by line reactance x, is Ix, and is shown 90° ahead of I. The Emf. consumed by line resistance r is Ir, and is shown in phase with I. The line voltage is drawn lagging behind the current I by the angle Φ and the generator Emf. Eg is also drawn lagging behind I by the angle Θ. This would only be possible in case there were synchronous machines, etc., that take leading current. In Fig. 2, Φ is reduced and Θ becomes zero, and the power factor at the generator becomes unity. Any further reduction of Φ will cause a lagging power factor at the generator. These two diagrams show that if there be line reactance, the current at the receiving end must lead the voltage in order that there may be unity power factor at the generator. It is obviously not possible to have unity power factor at both ends at the same time since the line reactance will cause E and Eg to be out of phase, and therefore I cannot be in phase with both at the same time.

In Fig. 3, I is line current, E is line voltage, Iw is wattless component of current, and Ip is power component of current. The power component Ip is the sum of the power component of the outside load Ilp and the power component of the synchronous motor, Isp. If the synchronous machine were acting as generator Ip would be their difference instead of their sum. The wattless component Iw is the difference between the load wattless component Ilw, and the synchronous machine component Isw when they are of different sign, that is, when one is lagging and the other is leading, but if both are lagging or both leading Iw is evidently their sum. Since Ilw is nearly always lagging and Isw is made leading to compensate it, Iw is usually the difference, thus Iw = Ilw — Isw, and Isw = Ilw — Iw.

In this figure Isw is the greater and Iw is negative, that is, leading, and in Fig. 4 Ilw is the greater and Iw is positive, that is, lagging.

Wattmeters on Low Power Factor Circuits, Ans. Ques. No. 294.

I would refer those interested in this question to the opening paragraph of Mr. Peck's article on page 190 of the May issue of Southern Electrician, in which it is discussed. The increased ratio of the readings of No. 2 to No. 1 is due to the fact that power factors are generally better on heavy loads than they are on light ones, and since the readings show that the average load was heavier the second month than the first the average power factor was probably higher. It is evident that as the average power factor approaches unity the ratio of the readings will approach unity also. T. G. Seidell.

Wiring for Industrial Plant, Ans. Ques. No. 281.

Editor Southern Electrician:

For direct current lighting and motor circuits the same general formula may be used for calculating the sizes of conductors necessary. With the drop in voltage permis-

sible, the current and the length of run determine the cross-sectional area. On an alternating current lighting system the formula also applies unless there are also, on the same system, induction motors which lower the power factor. The formula for copper wires is C. M. = (R. × D. × C.)/voltage drop.

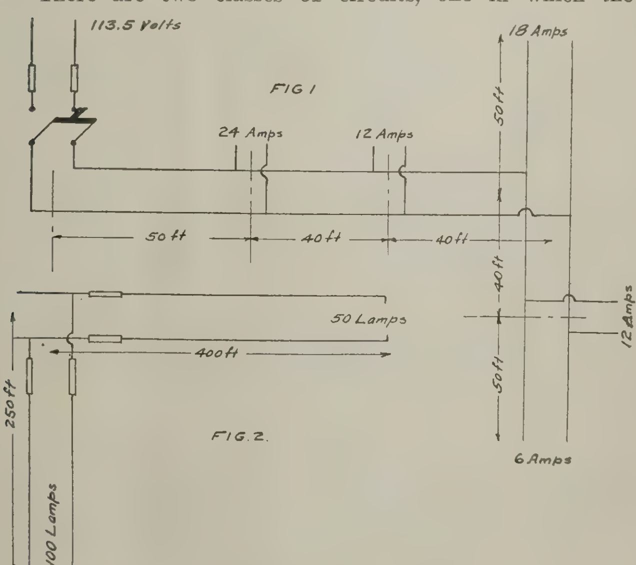
Where, C. M. = Circular mills cross section; R. = Resistance of 1 mill foot of copper (Matherson's Standard of purity) at a temperature of about 75 to 80 degrees Fahrenheit; D. = Distance of run in feet (for 2-wire circuit this equals twice the length); C. = Current required. For all ordinary installations the value R is assumed as 11. At freezing point, 32 degrees Fahrenheit, the value of R is 9.59. With rise in temperature there is an accompanying increase in the value of R ohms. For aluminum the value of R is 18.75 instead of 11 as for ordinary cases. For series systems as for arc light circuits D is the length in feet of the entire loop.

EXAMPLE.—Ten arc lamps requiring 50 volts and 10 amperes are placed at various outside locations of a large plant, the entire length of the loop being 6,000 feet. The voltage at the generator is 550 volts. What size of wire is required?

SOLUTION.—Ten lamps at 50 volts = 500 volts, because in series constant current circuits, the current passing through or consumed by the several lamps is the same, but the voltage depends upon the number of lamps in series. The generator voltage is given as 550. 550 — 500 = 50 volts, which is the maximum allowable drop for the conductors. Applying the formula C. M. = (11 × 6000 × 10)/50 = 13,200 circular mils. 13,200 C. M. is nearest, a No. 8 wire, which is used very much and is a stock size. No. 9 is about 13,000 C. M., but is often not a stock size.

As practically all interior lighting and motor circuits are multiple constant potential systems, several examples will best serve to explain the various methods of calculation. From inspection of the formula, it can been seen that increasing the length of run or the current requires a wire of larger circular mils area for the same voltage drop. Or if the drop in volts is decreased it will mean an increase in area of wire required to carry the same current the given distance.

There are two classes of circuits, one in which the lamps or motors are all approximately at a fixed distance from the service entrance or switchboard and one in which the lamps and motors are placed at various points on the system. Figure 2 is an example of the first. Here current is fed to 50 lamps, located in a room 400 feet away and to 100 more lamps located on the third floor of the building for which a run of 250 feet is required. The voltage at the point A is 230 and the lamps are 220 volt, 16 candle power carbon filament type requiring 50 watts each. The size of wire for the feeders to these two rooms is required.



FIGS. 1 AND 2. SHOWING LAYOUTS WHERE LOAD IS DISTRIBUTED AND WHERE CONCENTRATED AT CERTAIN DISTANCES.

First room.—(50 lamps × 50 watts)/220 volts × about 11.5 amperes. Voltage drop allowed is 230 — 220 = 10 volts. D = 2 × 400 ft. = 800 ft. C. M. = (11 × 800 × 11.5)/10 = 10,120 circular mils.

A No. 10 B. & S. gauge wire with rubber-covered, weatherproof or fireproof insulation, would be satisfactory. The allowable carrying capacity of a No. 10 wire can be found in Table I, which is ample for this case. Cartridge fuses of 20 amperes capacity and a switch of 25 amperes capacity as shown in the diagram would be approved.

Second room.—(100 lamps × 50 watts)/220 volts = 22.7 amperes required. D = 2 × 250 ft. = 500 ft. C. M. = (11 × 500 × 22.7)/10 = 12,485 circular mils.

12,485 circular mils is between No. 10 and No. 8 B. & S. gauge wire, so the larger would be chosen,—No. 8. While according to the table, a No. 14 wire carries 12 amperes and as for our first room only 11.5 amperes are required it would appear that No. 14 would be satisfactory. But because of the length of run, as shown by the formula, a No. 10 wire is required so that a voltage of 220 is delivered to the lamps. If a No. 14 wire were used the lamps would receive less than 220 volts and would burn at a much lower candle power. The drop with a No. 14 wire for this same case, can be found by the following formula, which is similar to the one used for the above example. Drop in volts = (R × D × C)/C. M. = (11 × 800 × 11.5)/4106 = 24. 4106 is the cross-sectional area of a No. 14 wire—see Table I. The lamps with a No. 14 feeder would be supplied with current at 230-24 or 206 volts. This drop is equal to 11 per cent. of line voltage.

It is assumed in Fig. 2 that the lamps in both rooms are installed on several branch circuits, none of which exceed 660 watts in capacity. In this case that means not over 13 lamps on a circuit, the circuit wires to be protected by branch fuses of 3 amperes capacity. If a single branch circuit is long, say 150 feet, it may be desirable to use No. 12 wire instead of No. 14, which is the size commonly employed.

EXAMPLE.—Two clusters of six 55-watt lamps each at 150 ft. on 110 volt system. Voltage supplied by feeders to branch circuit, 111. Voltage of lamps used, 108. (2 clusters × 6 lamps × 55 watts)/108 volts = 6 amperes required. Drop in voltage = (R × D × C)/C. M. = (11 × 300 × 6)/4106 = 5 volts. 111 — 5 = 106 volts supplied to lamps. With a No. 12 wire the drop equals (11 × 300 × 6)/6,530 = approx. 3 volts. In this case the voltage supplied to the lamps would be 111 — 3 = 108 volts. This is not so important, however, as 106 volt lamps could be provided for the first case.

EXAMPLES OF MOTOR LEAD CALCULATION.

Take a 10 horsepower motor located 100 feet from switchboard or service entrance. Voltage at this point 115 and motor designed for 110 volts.

If the normal full load running current of the motor is known, the same formula used for lighting circuits applies. In other cases the following formula serves the purpose. $C. M. = (R \times D \times H.P. \times 746)/V \times L \times E.$

Where, 746 watts equals 1 H.P. (one horsepower). V = voltage desired at motor, this case, 110. L = line drop in volts, this case 115 — 110 = 5. E = motor efficiency, this case 88 per cent. $C. M. = (11 \times 300 \times 10 \times 746)/(110 \times 5 \times .88) = 50{,}860$ circular mils.

No. 3 B. & S. gauge wire which has a cross-sectional area of 52,630 circular mils is satisfactory as far as the allowable drop is concerned. But the National Electric Code required that the leads to a direct current motor be of 25 per cent. greater carrying capacity than the rated full load current of the motor. In the example above, the current is, $(10 \times 746)/110 \times .88 = 77$ amperes. The conductors therefore must have a carrying capacity of 76 + 19 or 95 amperes. The ratings of No. 3, No. 2 and No. 1 copper wires are

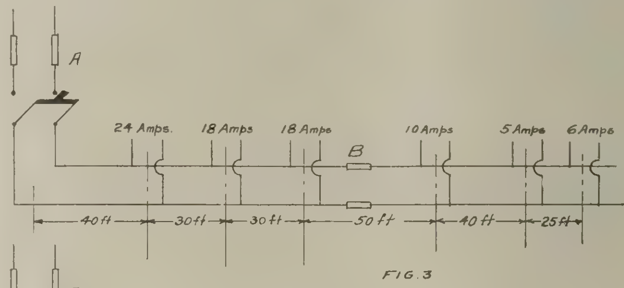
No.	Rubber Insulation.	Other Insulation.
3	76 amperes	110 amperes
2	90 amperes	131 amperes
1	107 amperes	156 amperes

Where rubber covered wire is used No. 2 wire could be used if the motor was started under light load but in most cases No. 1 wire would be better. If the wires were run open on knobs and weatherproof insulated wire used, No. 3 wire would fulfill all requirements. In all cases the fuses for these feeds must not exceed the allowable carrying capacities of the wires as given in Table I and the switch must not be of smaller rated capacity than the fuses.

TABLE I. TABLE OF CARRYING CAPACITY OF WIRES.

B. & S. G.	Table A. Rubber Insulation. Amperes.	Table B. Other Insulations. Amperes.	Circular Mils.
18	3	5	1,624
16	6	8	2,583
14	12	16	4,107
12	17	23	6,530
10	24	32	10,380
8	33	46	16,510
6	46	65	26,250
5	54	77	33,100
4	65	92	41,740
3	76	110	52,630
2	90	131	66,370
1	107	156	83,690
0	127	185	105,500
00	150	220	133,100
000	177	262	167,800
0000	210	312	211,600
Circular Mils.			
200,000	200	300	
300,000	270	400	
400,000	330	500	
500,000	390	590	
600,000	450	680	
700,000	500	760	
800,000	550	840	
900,000	600	920	
1,000,000	650	1,000	

The reason for providing leads of 25 per cent. greater capacity for direct current motors is to allow for the starting current which is always somewhat in excess of the running current of the motor. If this were not done the fuses would blow on starting and if larger ones were used, the wires would not be properly protected. Using larger wires allows the use of larger capacity fuses and these are not blown by the starting current and yet they protect the



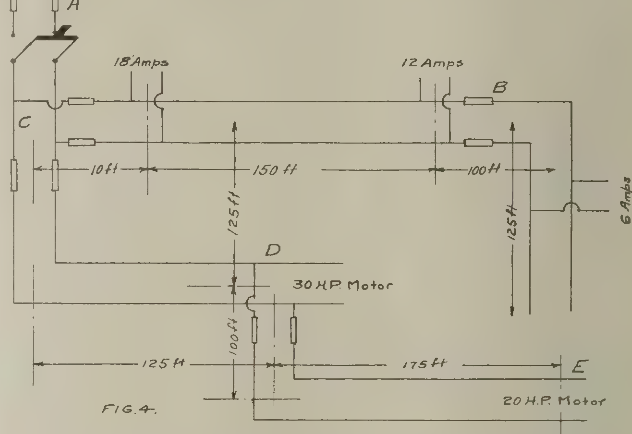


FIG. 3. CIRCUIT LAYOUT WITH CHANGE IN WIRE SIZE.
FIG. 4. COMBINED LIGHTING AND MOTOR CIRCUIT.

wires. Each motor and its starting or regulating rheostat must be protected by fuses and supplied with a switch for cutting off the current as shown in Figure 3. A single pole snap switch, however, may be substituted for the double pole knife switch for motors of ¼ H.P. or less where the voltage of the system does not exceed 300 unless this switch is used as the service switch. For this purpose a double pole switch would be necessary on a two-wire system. Small fan motors, adding machine motors, etc., may be connected to a branch lighting circuit providing that they do not overload it. For alternating current motors other factors must be considered and these will be discussed later.

In a large plant the load is distributed on the various floors, and in various parts of the building. Figures 3 and 4 show diagramatically systems having a distributed load. The amperes marked on the diagram, Fig. 3, indicate the maximum demand at each particular point. $D \times C$ as used in the formula $C. M. = (R \times D \times C)/\text{voltage drop}$ becomes the sum of the various currents times the lengths. In this $C. M. = [R \times (24 \times 100) + (12 \times 180) + (18 \times 360) + (12 \times 340) \times 6 \times 440]/3.5.$

$C. M. = 56{,}000.$

The voltage at entrance is 113.5 and the voltage required is 110. The distance between the various points is marked on the diagram. The total current demanded if all lights are burning is 24 + 12 + 18 + 12 + 6 = 72 amperes.

The wire nearest to 56,000 C. M. is No. 2, which with rubber-covered insulation has a capacity of 90 amperes and with weatherproof insulation, 131 amperes. This size wire

therefore provides for limiting the drop to 3.5 volts and easily carries the maximum current.

Figure 3 shows a system in which the size of wire is changed at the point B. By this means it is often possible to reduce the cost of wiring,—that is instead of using one size of conductor throughout, a smaller one may be used for one section or for more than one section in some cases. Wherever change in the cross-section of wires is made fuses must be placed in such capacities as to protect the smaller wires. This means additional cost of fuses and fuse block, and for small installations this cancels the saving resulting from the use of smaller conductors for parts of the feeder sections.

EXAMPLE—FIG. 3. Up to the point B, 60 amperes are required and beyond this 21 amperes. The voltage at A is 115; and 110 volts is required for the lamps, allowing a drop of 5 volts. As 81 amperes (total) are required, (by referring to Table I), we are safe in assuming a No. 2 wire (90 amps. see table) for the first section and a No. 8 wire (33 amperes) for the second part. Assuming these wires, we solve for the line drop and if this is too great or too small assume another size wire. Drop $= 11\ [(24 \times 80 + 18 \times 140 + 39 \times 200)/66{,}370]\ [10 \times 100 + 5 \times 180 + 6 \times 230)/16{,}510]$. Drop equals 4.25 volts, which is O. K. for this case, as 5 volts were allowed.

In the above equation 24×80 equals the amperes at the first feed point times twice the distance 40 feet (two wires). 18×140 equals 18 amperes times 2 times 40 plus $30 = 140$. 39×200 equals the 18 amperes at point B plus all the balance of the amperes on the line $18 + 21 = 39$, multiplied by the length of the line to the point where the size of wire is changed. 10×100 equals 10 amperes, times 2×50 feet, the distance from B, etc.

For the above example if wire of uniform cross-section were used we would solve as in the case of Figure 4.

C. M. $= 11 \times [24 \times 80) + (18 \times 140) + (18 \times 200) + (10 \times 300) + (5 \times 380) + (6 \times 430]/5$ volts.

C. M. = 40,144 circular mils, No. 4 wire.

In industrial plants we often have combinations of lighting and motor loads similar to the conditions shown in Figure 4. Here current is received at 235 volts and 220 volts is required for the lamps and motors, so that the drop to the most remote lamp or motor must not exceed 15 volts. In one feeder 18 amperes are taken at 10 feet, 12 amperes at 160 feet, there is a change in feeder wires at "B" and 100 feet from this point 6 amperes are required and at 225 feet, 12 amperes. Weatherproof wire to be used run open on knobs. The total amperes $= 18 + 12 + 6 + 12 = 48$. The total amperes from B to end $= 6 + 12 = 18$. Assume leads to point B, No. 5 wire = 33,100 circular mils. Assume leads from point B, No. 10 wire = 10,381 circular mils.

Drop in volts $= 11\ [(18 \times 20) + (30 \times 320)/33{,}33{,}100] + [(6 \times 200) + (12 \times 450)/10{,}381]$.

(II) $= 11\ [(360 + 9600)/33{,}100] + [(1200 + 5400)/10{,}381]$.

$= 11\ [(.3 + .63) = 11 \times .93 = 10.23$ volts.

We are allowed 15 volts drop, so a little smaller wire may be used. Substituting 6,530 C. M. (No. 12 wire) for 10,381 in line marked II above we have drop =

$11\ [(360 + 9600)/33{,}100 + (1200 + 5400)/6530] = 11\ (.3 + 1.0) = 11 \times 1.3 = 14.3$ volts.

This is nearly 15 volts and we can therefore save money by using No. 12 wire instead of No. 10 as at first assumed.

For the motor lines we solve separately.

Normal full load running current of motor at D $= (30 \times 746)/220 \times .92 = 110$ amperes.

Normal full load running current of motor at E $= (20 \times 746)/220 \times .90 = 75$ amperes.

Total $= 110 + 75 = 185$ and motor leads must be capable of carrying 25 per cent. more current than the running current. Weatherproof insulated wire No. 000 B. & S. gauge has an allowable carrying capacity of 262 amperes and area of 167,800 circular mils. We will assume this wire for the section to D and a No. 3 wire for the rest. No. 3 has an area of 52,630 C. M. and with weatherproof insulation a capacity of 110 amperes which is more than 25 per cent. more than 75 amperes, the rated current of the motor at E. We will solve for the line drop and if this is not greater than 15 volts the wires assumed (Nos. 000 and 3) may be used. Drop $= 11\ [(110 \text{ amps.} + 75) \times 500 \text{ ft.})/167{,}800 \text{ C. M.} + (75 \times 450)/52{,}630] = 11\ (.55 + .64) = 11 \times 1.19 = 13.1$ volts drop.

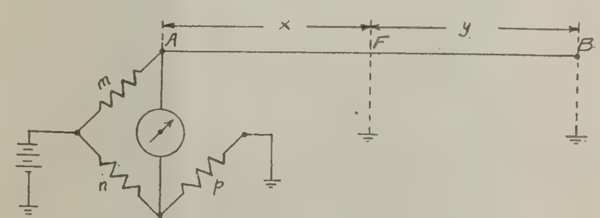
Therefore the wires assumed provide for supplying the current to the motor at least 220 volts and at the same time comply with the underwriter's requirements as to 25 per cent. greater capacity.

Entrance wires to a building should have rubber insulation, at least from the last supporting insulators on the outside of the building to the main fuses and switch on the inside. Where tubes are used for bushing the hole in outside walls they should be set an an angle, and a drip loop placed outside at the lower end to drain off rain and moisture. Conduit is now used very extensively for protecting the wires at the service entrance and double braid rubber covered wire, as required for conduit construction, employed. The main service fuses and switch should be placed accessibly, so that in case of accident or fire the main switch can readily be opened to cut off the current from the entire installation. G. J. KIRCHGASSER.

Earth Over-Lap Method Bridge Test, Ans. Ques. No. 297.

Editor Southern Electrician:

The writer is not sure that the name of the test given by E. R. H. in the May issue is correct. No test where the far end is grounded has ever come to the writer's attention, although he has read over many standard works. In fact there seems to be no good reason for grounding B when reading with a bridge at the point A, it complicates matters and does not in any way give greater accuracy. If it were not for this point, the test would readily be recognized as a common test for locating crosses where no available parallel wire is at hand.



CONNECTIONS FOR EARTH OVER-LAP BRIDGE TEST.

The equations for using the test according to the diagram given is as follows, assuming that the resistance of the ground is negligible. This means that the resistance

through ground from A to ground at F plus resistance from this point to B may be taken equal to zero.

Let $X =$ actual resistance from A to point F.

$Y =$ actual resistance from B to point F.

$Z =$ actual resistance of fault.

$M =$ measured resistance from point A, with B grounded.

$N =$ measured resistance from point B, with A grounded.

$R =$ total resistance of fault wire $= X + Y$.

Then $M = X + (YZ)/(Y + Z)$.

$N = Y + (XZ)/(X + Z)$.

$X = [M(R - N)/(M - N)]\ [1 + \text{or} - \sqrt{[N(R - M)/M(R - N)]}]$.

$Y = [N(R - M)/(N - M)]\ [1 + \text{or} - \sqrt{[M(R - N)/N(R - M)]}]$.

The above test requires that the instruments be carried to both ends of the line and fails when the resistance of the fault changes. A test which has been suggested by Mr. Montford Morrison, physicist for the Morrison Company, of Atlanta, Ga., eliminates this difficulty. The instrument is placed at the point A with B grounded and the instrument varied with the change of resistance of the fault so that the instrument continuously indicates the resistance of the circuit. An assistant at B breaks the circuit at that point, when the reading at A is noted, and the resistance of the remaining circuit $(X + Z)$ is taken, Z being constant for a fraction of a minute. The equations for this modification of the test are as follows:

The measured resistance from point A is then as before,

$$M = X + (YZ)/(Y + Z) \qquad (1)$$

Knowing the resistance of faulty wire to be $R = X + Y$, then $Y = R - X$. Substituting these values in equation (1),

$$M = X + [(R - X)Z]/(R - X) + Z \qquad (2)$$

By evaluating Z in terms of X, the equation can be at once solved. By breaking the circuit at B, the resistance reading will be $R' = X + Z$ or $Z = R' - X$. Substituting these values in equation (2) we have,

$$M = X + (RR' - R'X - RX + X^2)/(R + R' - 2X).$$

This may be reduced to a quadratic equation of these terms,

$$X^2 - 2MX + (MR + MR' - RR') = 0$$

Thus solving for X, we have,

$$X = M + \text{or} - \sqrt{[(M - R)\ (M - R')}.$$

The minus sign usually gives the desired result in practice.

PROF. T. V. THROWER.

Spacing of Wires on Distribution System, Ans. Ques. No. 296.

Editor Southern Electrician:

In answer to Question 296 in the May issue, on spacing of wires for low voltage circuits, I would say that the arrangement stated is due to the fact that standard cross arms are of the two, four, six and eight pin type, and to get the spacing of wires where there is to be only one circuit, the four pin arm would probably be used and there must be a wire on each side of the arm to balance the strain on the arms and poles. If two circuits are to be strung the six pin arm is used and one circuit placed on each side of the arm. There are no electrical reasons that cause the practice mentioned on low voltage circuits.

E. D. DUMAS.

New Apparatus and Appliances.

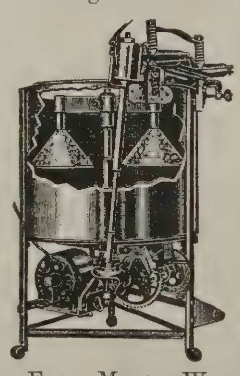
The Easy Motor Washer.

There are many motor driven washing machines on the market, each having varying degrees of merit. A successful type of washer manufactured by Dodge & Zuill, of 507 East Water Street, Syracuse, New York, is illustrated herewith. The tub or tank of this washer is made of cold rolled copper with the bottom reinforced by a plate of galvanized steel and stiffened by a bar of channel steel. It is further supported by steel braces running from center of bottom to the legs on which the tub is mounted. To the plates thus secured is attached the operating machinery, condensed under the tub and out of the way.

The water discharge, which is commercially known as a brass throttle valve, screws into a specially prepared brass base in bottom of tub. Its outer end is threaded for connecting to the sewer system, and is equally convenient to discharge into pail or open sewer. The suction basins, which are attached by a thumb screw to upper end of piston rod, are automatically adjusted to the load by means of compression springs in the basin staff. In the operation of washing, these basins make 60 impulses per minute, turning automatically at the top of each revolution for a new position on the down movement. In these movements it is said that the load is systematically covered and so great an agitation produced by air pressure process that the worst soiled clothing cannot escape being cleaned and the most delicate piece of fabric cannot be injured.

The power is shifted from washer to wringer by means of a hand clutch lever conveniently located near the bottom of tub. It is positive in its operation, stopping the washer and starting the wringer instantly without turning off the power. The wringer is reversible by means of a little lever conveniently located near the top of upper roll. The power is applied through a set of bevel gears, making it positive and powerful.

The gas attachment is provided when any user has convenient access to gas service, either natural or artificial. When operating at full capacity, the usual quantity of wash water is heated to the scalding point in 25 to 30 minutes, and may be regulated for any temperature desired to maintain. Heating the suds in the washer by gas



THE EASY MOTOR WASHER.

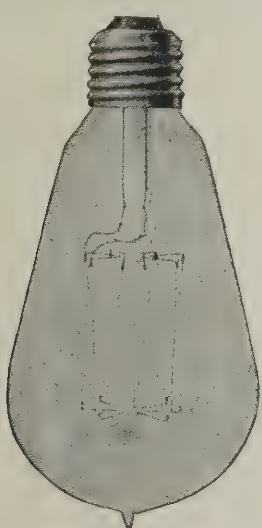
while electricity is doing the washing means sanitary cleansing by the simplest process possible.

A New Conduit.

The Central Tube Co., of Pittsburg, Pa., for a number of years past manufacturers of pipes for rigid conduit, has placed on the market a complete line of electrical conduit, having taken over the organization of an established conduit manufacturing company. The conduit will be marketed under the name of Central White, Central Red, and Central Black. The Central White conduit is heavily coated with zinc by an electro-galvanizing process and is claimed to be non-corrosive. The interior is covered with a special red enamel. Central Red is an interior conduit, constructed similar to Central White, but also coated, with red enamel over the zinc exterior. This conduit is manufactured to withstand trying conditions, such as are encountered in sea coast towns and in all underground work where gases are present. Central Black has a double coating of high grade elastic enamel on both the interior and exterior. Like the two other grades it is unnecessary to clean threads on the job, the pipe is thoroughly welded and is recommended for bending or for working up in any way. All conduit has the approval of the National Board of Fire Underwriters.

The Newman Lamp.

The Newman Electric Lamp Co., of Cincinnati, Ohio, has recently placed upon the market both carbon and tungsten lamps. The carbon lamps are offered in 4, 8 and 16 candle power sizes for ordinary illuminating purposes and for operation on voltages of 100 to 130. Two and four candle power sign lamps are also offered for operation of



THE NEWMAN TUNGSTEN LAMP.

voltages from 200 to 260. The tungsten lamps are of the wire-drawn type with strong filaments, said to have an average life of 1,100 hours. Sizes from 25 watts to 450 watts are carried.

Transformers for the Southern Sierras Power Co.

The Fort Wayne Electric Works is furnishing the Southern Sierras Power Company with a large number of distribution transformers for outdoor service on 33,000 volt, 60 cycle circuits. The transformers are of the shell type construction, with separately wound primary and secondary coils. Each coil has a continuous layer of insulation, and is spaced and separated from the other coils by means of heavy insulating channels and shields. The primary winding is so arranged that the taps are brought out from the interior, or neutral part of the winding in order to minimize danger of trouble at this point. The terminal block is submerged in oil. The wire used in the high voltage winding is first enameled and then double cotton covered. That portion of the winding which connects to the line has four cotton coverings, and the last turns of each coil are furthermore individually wrapped with a double thickness of varnished cambric or empire cloth so that each turn will withstand several thousand volts breakdown test. This extra heavy insulation on the end turns is to enable the transformer to stand up under high frequency discharges and line surges.

The high tension insulators, tested at 80,000 volts, are cemented to an auxiliary cover bolted to the main cover; after the core, coils and main cover are in place the final connections between the coils and the high tension terminals are made through an additional hand-hole in the main cover which at the same time provides a convenient means of filling the transformer with oil.

The transformers have successfully withstood breakdown tests of 70,000 volts between primary and secondary and ground. Especial care is taken in the construction of these transformers to prevent injury to the coils and core due to shifting during shipment. A heavy cast iron cradle bolted to the base of the tank so supports both core and coils that there is practically no possibility of their shifting.

New Reversible Motor Starter.

The reversible motor starter illustrated below is a new type recently put on the market by The Cutler-Hammer Manufacturing Company, of Milwaukee. For service requiring a motor capable of being operated at full speed in either direction the reversible starter combines in one device means for proper acceleration of the motor. One operating lever only is required but two no-voltage release latching devices are provided so that the lever will be held in the full speed position in either direction. Interruption of current supply or excessive voltage drop causes the operating lever to be thrown to the central, or off, position by a centering spring after the release magnet has dropped the latching device. Renewable segments are employed.

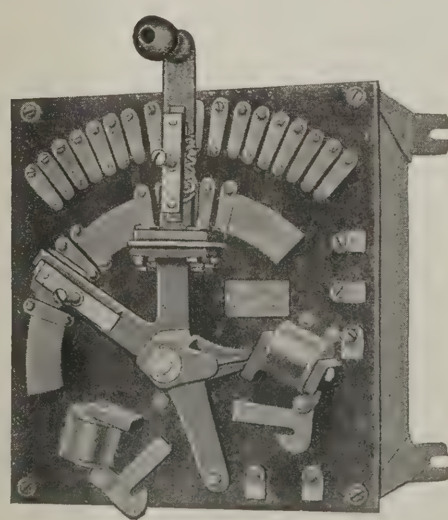


FIG. 1. REVERSIBLE MOTOR STARTER.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

ATHENS. A vote will be taken June 7th on the issue of $12,000 in bonds for the purpose of making repairs to light and waterworks system. The city engineer, E. P. Henderson, can give other information.

BIRMINGHAM. The Birmingham Railway, Light & Power Co., has petitioned the city to place electric wires underground in the business section.

GENEVA. The Geneva Power Co. has been incorporated with a capital stock of $8,000, which is understood as only nominal. A company proposed to erect an electric power plant and it is understood that D. O. Vaughan is the principal investor.

HARTSELLE. It is understood that a lighting plant is planned for this place.

JACKSON SHOALS. The development of the Alabama Power Development Company is nearing completion.

TUSCALOOSA. The Tuscaloosa Ice & Light Co. has secured a franchise and will build an electric light and power plant.

GEORGIA.

ATLANTA. The Georgia Railway Commission, of Atlanta, has given its permission to the Central Georgia Transmission Co., of Macon, Ga., to issue $2,000,000 of common stock and $2,500,000 in bonds to be used as follows: General organization, $25,000; purchase of rights of way and construction of 66,000-volt steel tower transmission lines from Griffin to Atlanta, $188,500; erection of brick and concrete sub-stations for a 9,000 k. w. sub-stations with apparatus in Atlanta, $82,500; also sub-stations at Hampton & Jonesboro with apparatus, $25,000 each; acquisition of land and erection of steam plants of 5,000 k.w., $425,000; construction of distribution lines in and around Atlanta, $117,500, acquiring right of way, construction and equipment of 66,000-volt transmission from Griffin to Barnesville, Thomaston, Manchester, Newnan, LaGrange, and West Point, a distance of 150 miles; 11,000-volt transmission to Grantville, Hogansville, Palmetto, and Fairburn, 46 miles with sub-station at Thomaston, Manchester, Newnan, LaGrange and West Point, and 31 miles of distributing line, $1,035,000; acquiring lands for $66,000-volt high-tension lines from Central Georgia Power Company's plant at Ogmulgee River to Covington, Social Circle, Madison, Monroe, Monticello, and Eatonton, 81 miles and erection of sub-stations at each city of 9,000 k.w. capacity and 30 miles of distributing lines at each station, $685,000. The plans call for 288 miles of transmission lines, 95 miles of distributing systems, an auxiliary steam plant in Atlanta and 14 sub-stations with combined capacity of 26,100 k.w. Consulting engineers for the company are Riggs & Anderson, of Ann Harbor, Mich.

AUGUSTA. G. Lloyd Preacher desires prices on a storage battery lighting system.

CARTERSVILLE. The city will vote about the 1st of June on the issue of $50,000 to be extended on the electric lighting system. Further information can be obtained from the Mayor, G. W. Young.

DAWSON. It is understood that new equipment will be added to the municipal electric light plant. The mayor can give other information.

ELLAVILLE. The city has made arrangements to construct an electric light plant and has awarded the contract of construction to the Bayzard Construction Co.

LAVONIA. The city has voted to issue $50,000 in bonds for the construction of an electric light plant.

MACON. Application has been made to the Georgia Public Service Corporation, by W. J. L. Massey and associates, to build a large steam power plant.

STONE MOUNTAIN. It is understood that the construction of an electric light plant is under consideration.

MACON. F. R. L. Stroberg at 706 Broad St., desires prices on gas and electric light fixtures for a 10-room dwelling.

FLORIDA.

HASTINGS. It is understood that an electric light plant is proposed, the cost of which will be about $10,000.

LAKE HELEN. The city will vote on the issue of bonds for the installation of an ice, water, and electric light plant. Information can be secured from A. G. Clarkson, Secretary of the Sandstone Brick Co.

KENTUCKY.

BARBOURVILLE. The Barbourville Light, Heat and Power Co. has been purchased from T. S. Gibson, by A. G. Smith, and G. W. Tye. It is understood that considerable improvements will be made.

BOWLING GREEN. The Kentucky Public Service Co., which owns the plant of the Capital Gas & Electric Light Co., of Frankfort, Ky., is preparing to improve its power house. The company is also making similar improvements at Bowling Green, Ky.

HOPKINSVILLE. It is understood that the Mogul Wagon Works, of which J. S. Eihle is general manager, is in the market for an engine.

RICHMOND. Plans have been perfected for continuing the work on the construction of the plant of the Richmond Lighting Co., on the Dix River. This plant will be operated by the Dix River Power Co., which has been recently incorporated.

LOUISIANA.

BOGALUSA. The Colonial Creosoting Co. has been incorporated in Louisville with $100,000 capital stock for the purpose of establishing a plant for treating railway ties. H. E. Hurdle, of the American Creosoting Co., with headquarters in Louisville, is president of the new company.

LAKE CHARLES. Bids will be received until 10 a. m. June 4th for electric fans and lighting fixtures for Calcasieu Parish court house at Lake Charles. The plans and specifications may be secured at the office of the architects, Favrot & Livaudais, Ltd., 839 Gravier St., New Orleans, La.

MISSISSIPPI.

SUMMER. The city has recently voted $22,500 in bonds for the construction of an electric light plant. The mayor, H. L. Whitton, can give other information.

YAZOO CITY. $10,000 in bonds will be sold for improvements to electric light and waterworks. The new machinery will be installed. The engineer in charge is Mr. C. E. Ard.

NORTH CAROLINA.

BURLINGTON. A company known as the Alamante Power Co. has been organized for the purpose of constructing a hydroelectric plant at River Falls, on the Haw River. The officers of the company are F. L. Williamson, president, of Burlington; J. H. White, of Graham, N. C., vice-president; C. E. Menefee, of Burlington, secretary.

GOLDSBORO. The Carolina Power & Light Co., of Raleigh, N. C., has purchased the municipal plant and has a 60-year franchise for lighting. The consideration in purchasing the plant was $125,000. This company has light and power franchises for Wadesboro, and has begun the construction of a transmission line from the Blewett Falls hydro-electric plant. A number of contracts have been made for textile mill power and a second line has been started to Cheraw, S. C., by way of Hamlet, and a third line to Lumberton, N. C., where power will be furnished to various factories.

WALLACE. The Greenfield Park Development Co. desires prices on a smaller generator of a capacity to furnish energy to 150 to 300 lights of 16 c.p. or greater. Wire and other equipment for the plant is also required. W. C. Brice is manager and his address is Box 22, Wallace, N. C.

SOUTH CAROLINA.

BARNWELL. The city will vote shortly on the issue of bonds to the extent of $22,000 for the construction of an electric light plant and waterworks system.

CAMDEN. The city will vote on June 11th for the issue of bonds to the extent of $100,000 for the construction of light and water plants, or the purchase of a system.

PENDLETON. The city has contracted with the Autumn Mfg. Co., of Anderson, to furnish electricity for lighting the streets and buildings.

ST. GEORGE. The city has plans under way for the construction of an electric light plant. Further information can be obtained from J. H. Whetsell.

UNION. The Union Buffalo Cotton Mills Co. are making arrangements for the installation of a large auxiliary steam plant to cost approximately $150,000 and to be located at Neal Shoals.

TENNESSEE.

CENTREVILLE. The company undertaking hydro-electric development on Duck River has secured power rights at two sites which are capable of developing 10,000 horsepower. The consulting engineers are the Reliance Engineering Co., 4th National Bank Bldg., Cincinnati, O.

CHATTANOOGA. It is understood that the Merchant's Retail Association is promoting the installation of an extensive lighting system along a number of the important streets.

CLINTON. The Tennessee Hydro-Electric Co. has been incorporated with a capital stock of $100,000 for the purpose of building water power plants on the Clinch and the Powell Rivers. It is understood that two dams will be built on the Clinch River, and options on the necessary lands have been secured. The incorporators of the company are J. R. Paul, of Pittsburg; J. B. Cox, of Knoxville; F. M. Butler, J. B. Cox, and J. M. Wallace, of Clinton, Tenn.

NASHVILLE. The Tennessee Power Co. has been incorporated with a capital stock of $20,000,000 by the following: F. H. Yost, D. E. McGugian, Harrison Grawoig, Edward Florence, and Isaac Milkewitch. It is understood that the company is controlled by the H. M. Byllesby & Co., of Chicago, the E. W. Clark & Co., of Philadelphia, and others. This company has taken over the Eastern Tennessee Power Co., which has changed its name to the Warren County Power Co. It will also operate hydro-electric plants on the Ocoee River and Kennyforks. Three plants will be built on the Ocoee, one having been erected, another being in course of construction and a third to be built a little later. The proposed details of this organization were reported in the last issue of Southern Electrician.

PERSONALS.

WM. D. WEAVER, who for the past 19 years has been chief among American engineering journalists, has retired from active work as editor of the "Electrical World." Every one who has been a careful reader of the "Electrical World" since 1893 has felt the influence of this man in all lines of engineering work and knows him to be the backbone of the highest type of technical journalism. Starting on a publication of comparatively small circulation, he has created a respect among engineers for a technical journal through the aims, policies and ideals for which he has stood and he now leaves, as a monument for his efforts, the most influential electrical publication in the world.

At the time of Mr. Weaver's announcement of his intention to retire from active service, his many warm friends gave expression at a dinner, of their feeling in regard to his past work. Perhaps the most impressive of all, are the remarks of James H. McGraw, president of the McGraw Publishing Co., from which we quote:

"For many years I have known W. D. Weaver, as man, as engineer, and as editor. More than that, he is my warm friend. Now that he is about to retire, we who have lived and worked with him have one great consolation—that we are not to be deprived of his counsel or shut off from the stores of his knowledge. He will be consulting editor of the 'Electrical World.' Weaver's character as a man has a peculiar charm born of the combination of many opposing attributes. With a modesty and gentleness so pronounced that it may be called invincible he has a virility of will and independence of thought that have made him always a master and leader. A man of letters and of science, given to abstractions and generalizations, he is never forgetful of the concrete and human side of human relations. A man of the world, a cosmopolitan with an extremely wide range of travel, observation and personal experience, yet he is simple, plain and unostentatious in his habits and mode of life. A man who knows no guile, he is always rigorously honest and appreciatively sympathetic. Weaver is a real man, though he may be a little old-fashioned in that he is never boastful and delights in seeing credit given to others for things that he has done."

MR. H. G. SCOTT, who for some time has represented the Shelby Electric Co., as Southern manager, has accepted the position of commercial engineer with the Central Georgia Transmission Co., and will be located at Atlanta. Mr. Scott is well known in the Southeastern States as a champion at selling lamps and playing golf. His success has been due in a large measure to the fact that those whom he has come up against always come back for more in both cases. So far as he knows or any one has dared to confess, there is yet a Southern office to place a larger number of lamps in the same length of time in his territory.

Judging from the record made in the lamp and golf fields, it will only take Scott a short time to force his organization to raise another five million dollars and make plans for further generating facilities to accommodate the power consumers waiting in line to connect with the transmission system, for Scott knows his business in the engineering field just as well as on the golf links. His many friends wish him all success.

MR. H. T. EDGAR has been appointed manager of the Seattle division of the Puget Sound Traction, Light and Power Company, which is a consolidation of The Seattle Electric Company, the Seattle-Tacoma Power Company and the Pacific Coast Power Company.

The Seattle Electric Company operated a street car system and a large part of the electric lighting service in Seattle. The Seattle-Tacoma Power Company also operated an electric lighting system in Seattle and furnished light to a number of suburban towns. The Pacific Coast Power Company was the owner of the White River development, the large water power plant recently completed on the White River.

MR. FRANK DABNEY, Assistant Treasurer of The Seattle Electric Company, has been appointed to a similar position with the Puget Sound Traction, Light & Power Company, which took over the Seattle Electric Company April 18.

MR. W. E. BEST, formerly treasurer of the Seattle-Tacoma Power Company, is now auditor of the Puget Sound Traction, Light & Power Company, under the consolidation of the Seattle Electric Company, the Seattle-Tacoma Power Company, and the Pacific Coast Power Company, which became effective April 15.

FRANK C. BARRINGTON, sales manager of the St. Joseph Railway, Light, Heat and Power Company, has accepted a position with the Westinghouse Electric and Manufacturing Company and will take up his new work at the plant in Bloomfield, N. J., near New York City, June 1. He will be connected with the incandescent lamp department.

Mr. Barrington has spent practically all his life in St. Joseph. He began his career in the electric field in 1892, with the old People's street railway, which effected the consolidation of the several local lines, with W. T. Van Brunt as general manager. In 1893, he together with George C. Rough, now sales manager of the Packard Electric Company, Toronto, and Chas. E. Roehl, electrical engineer for the Brooklyn Rapid Transit Company, at Brooklyn, organized the Columbian Electric Company here and he was its president and manager until a few years ago, when he disposed of his interest and returned to the services of the street railway company.

Barrington's successor here will be F. C. Pullen, formerly with the General Electric Company at St. Louis, who comes to St. Joseph from the Evansville Electric Light and Power Company, at Evansvile, Ind. Mr. Barrington's family will remain in St. Joseph for the present. His son, Edmund, expects to enter Shattuck Military Academy at Fairbault, Minn., next fall.

GEORGE W. ARMSTRONG, who becomes general manager of the Korting and Mathiesen Co., has been one of the most active and enterprising exponents of flaming arc lamps in this country and for years was manager of the Excello Arc Lamp Co., of New York. Mr. Armstrong is a native of Ohio and was for some time a successful business man in that state. He established his first connection with the flaming arc industry in 1906, opening the office of district manager of the Excello Arc Lamp Company in Columbus, O. He was at that time salesman and agency organizer of the company and in February, 1908, was sent to Chicago by the company to establish the western office. In this connection, Mr. Armstrong carried out a number of notable installations of Excello flaming arc lamps, some of the largest steel mills and other industrial plants being his customers. Mr. Armstrong will make his headquarters at the head office in New York and will be assisted by a strong organization of illumination experts, many of whom have for a long time been closely identified with the marketing of the Excello lamp.

INDUSTRIAL ITEMS.

THE HABIRSHAW WIRE CO., of 253 Broadway, New York, moved April 1 to more commodious and luxurious offices on the 27th floor of the Metropolitan Tower, Madison Avenue. Here they will be glad to welcome any of their friends who may happen to be in the city. We might state that the bird's eye view of the city obtained from the tower is well worth a visit.

THE APPLETON ELECTRIC CO. of Chicago, is distributing a new 84-page catalogue. It is complete and covers in detail all the material manufactured by that company, which makes a specialty of sherardized fittings, and have many new features in the line of Unilets which should be of interest to engineers and electrical contractors throughout the country.

THE WESTINGHOUSE ELECTRIC & MFG. CO. reports an order for six direct-current 60-ton Baldwin-Westinghouse electric locomotives and 20 Westinghouse car equipments with H L control, by the Southern Pacific Railroad Company, for op-

eration on the Southern Pacific and Pacific Electric Company properties. Both the car and locomotive equipments are arranged for operation on either 600 or 1200 volts. Most of the property now operates at 600 volts, but there are portions at 1200 volts, and the double voltage equipment was selected so that it might be used on any portion of the system and on such 600 or 1200 volt extension as may be built in the future. The 60-ton locomotives, each of which will have an aggregate motor capacity of 1000 H. P., will be the largest 1200 volt locomotives ever built.

WESTERN ELECTRIC interests are inclined to regard the industrial situation with increasing confidence, begot by the favorable reports from the corporation's branch houses scattered over this country and abroad. Conditions of late have shown a substantial improvement, especially in the East, where the March returns and the returns for the first quarter show a substantial gain over the same periods last year. The West is somewhat behind as the result of a late spring accompanied by heavy snows in some sections.

Decreases which marked the first two months of the Western Electric's current year came to a halt in March, when sales ran about equal with March, 1911. The first quarter of 1912 shows sales at rate of about $67,000,000 for the year, or slightly better than 1911, which showed sales of $66,200,000.

THE CHICAGO FUSE MFG. CO., of Chicago, has issued catalogue No. 26 covering the "Union" line of fuse protecting materials. Particular attention is called to the additions to the line of National Electrical Code fittings and high voltage fuses and blocks. The subject of refilled fuses is also carefully treated. The tabulation and arrangement adopted throughout the catalogue makes it convenient for ready reference connecting catalogue number with the other features. The catalogue will be sent upon request.

THE WEYBERG ELECTRIC & MECHANICAL WORKS, of St. Joseph, Mich., has installed at plant of the Butler Municipal Electric Light Co., at Butler, Mo., a 30 K.W direct-connected generating set. A 15 K.W. set is also being installed by the same company at Fargo, N. D.

THE WESTINGHOUSE ELECTRIC AND MFG. COMPANY recently shipped from East Pittsburgh to the Pennsylvania Water Company at McCall's Ferry, Pa., a 10,000 Kva. 3-phase, 70,000/11,000 volt, 25-cycle transformer to be used in connection with the transmission of electrical energy to Baltimore. The transformer is a duplicate of several others which were shipped some time ago and an additional one is now being built which will be used in the Baltimore sub-station.

ALFRED F. MOORE, manufacturer of insulated wire for all electrical purposes, has established sales agencies at Chattanooga, Louisville, and Birmingham carrying magnet wire and weatherproof wire at the first two points with a supply of weather-proof, office, annunciator, and rubber-covered wires and lamp cord at Birmingham.

THE H. W. JOHNS-MANVILLE COMPANY, already well known in the lighting field by reason of their J-M Linolite System of Illumination, have acquired the sole selling agency for the entire products of I. P. Frink, including reflectors and illuminating specialties. Frink reflectors and fixtures need no introduction to the lighting trade and consumers throughout the country, and this arrangement means that the H. W. Johns-Manville Company will be in position to design and sell lighting systems for every known form of artificial illumination.

The standing of these two respective companies throughout the country places the stamp of merit on this combination, and undoubtedly all interested in artificial illumination will be benefited by the uniting of these forces, as the Frink Company have been following this particular line of work for the past fifty consecutive years. An Engineering Department will be maintained along very extensive lines. This department will maintain a corps of engineers throughout the United States and Canada, and be equipped to place data and recommendations in the hands of all interested in any subject pertaining to illumination.

THE PHILADELPHIA RAPID TRANSIT COMPANY and the International Railways Company, of Buffalo, N. Y., have awarded a contract to the Westinghouse Electric & Manufacturing Company for 500 complete car equipments. Each equipment consists of two No. 306-C box frame, interpole railway motors, rated at 50 H. P., 500-volts, type K-36 controllers and Westinghouse car type circuit-breakers.

BETTS AND BETTS COMPANY, of 306 West 53rd street, New York, have recently issued a mechanical flasher Bulletin, descriptive of various types of flashers. It also shows the latest designs in flashers and the largest and most complicated flasher ever built.

ELECTRIC FLASHERS. The Reynolds Electric Flasher Mfg. Co., has issued a bulletin descriptive of the Thermotype Flasher for small signs, window displays, oculist's and jewelers' signs and for various other signs where few lamps are used.

TRADE LITERATURE.

DATA ON ORNAMENTAL STREET LIGHTING. The Sterling Electric Co., Warren, Ohio, has published a treatise on the Mazda Lighting systems covering all information, data and cost of ornamental systems and giving illustrations and descriptions of the various types of posts and installations. The data contained in this treatise is without question the most complete ever published. This company has also issued in booklet form a description of the ornamental systems as installed at Warren, Ohio.

ELECTRIC SIGN TRANSFORMERS. The Reynolds Electric Flasher Mfg. Co. has issued a bulletin describing Reco Multiple Lighting Transformers for electric signs. Several sizes of these transformers are manufactured ranges from 150 to 2,000 watts capacity for electric signs using low voltage tungsten or Mazda lamps. The transformers are designed to step down from 220 or 100 to 10 and 11 volts.

CONDENSERS. The Westinghouse Machine Co. has issued a second edition of the instruction book covering the Westinghouse LeBlanc Condenser. The work covers a description with suggestion and instructions for the installation, care and operation of the condenser.

INDUCTION MOTORS. The Crocker-Wheeler Co., of Ampere, N. J., has recently issued a small booklet on Crocker-Wheeler Induction Motors, giving some of the advantages claimed for Crocker-Wheeler motors over other motors and taking up particular features of design which are characteristic of the motors manufactured by the company.

TRANSMISSION STRUCTURES. The Archibald Brady Co., engineers and contractors, of Syracuse, N. Y., has recently issued an attractive bulletin on steel transmission structures. The bulletin is illustrated with remarkably clear half-tone cuts giving details of the construction of the towers manufactured by the company. The reproductions are actual illustrations of structures now in operation.

LIGHTING FIXTURES. The Philadelphia Electric Co., of 132 South 11th Street, Philadelphia, Pa., recently issued a folder on series street lighting with Cutter's cable grips, suspension street hoods. These devices are especially adapted to high voltage circuits and for use with tungsten series lamps for street illumination.

SINGLE-PHASE MOTORS. The Bell Electric Motor Co., of 30 Church Street, New York City, has issued a bulletin descriptive of the Bell high efficiency single-phase motors. The bulletin contains considerable information of interest to central stations, manufacturers of machinery and electric contractors, the contents of the bulletin being devoted to subjects of interest to them. The test curve of a five H. P. 1,800 RPM, 220 volt, 60-cycle high efficiency single-phase motor reveals the actual operation of it.

MOTOR STARTERS AND FIELD REGULATORS. The Union Electric Mfg. Co. is distributing in bound form bulletins published by the company on electric controlling devices. These devices cover motor starters for all purposes and field regulators of different types and designs.

STORAGE BATTERY CARS. The Berg Storage Battery Car Co., of the Hudson Terminal Building, New York City, has issued a description of electric storage battery cars treating the features and advantages of these cars over other systems.

WIRE REELS AND METERS. The Minneapolis Electric & Construction Co., of Minneapolis, Minn., has placed on the market a device for measuring and reeling wire and cordage of various sizes. The device consists of a meter and reel mounted in such a way that as the wire is wound on the reel, a record is made of the number of feet in the coil, thus doing away with measuring on the floor.

ALTERNATORS. The Electric Machinery Co., of Minneapolis, Minn., has issued bulletin No. 126, describing the various types of alternators manufactured by the company. The details of construction are carefully treated and various types illustrated.

ELECTRIC OVENS. The Dispatch Mfg. Co., Minneapolis, Minn., has issued a very attractive bulletin descriptive of Dispatch Electric Ovens manufactured in sizes and types for every purpose. This company claims to be the largest exclusive manufacturers of electric ovens in the world and it is prepared to furnish ovens of any character.

CONDENSITE. The Condensite Company of America, of Glenridge, N. J., has issued in bulletin form descriptive material in connection with Condensite, a gum-like substance, transparent, hard but brittle, fusible at moderate temperatures and does not harden under the action of heat, is soluble in alcohol and similar solvents. It is adaptable to many uses, including the following: Electric insulation, phonographic records, valve disks, buttons, handles, gun butts and revolver grips, billiard and pool balls, and various other similar products.

RESISTANCE UNITS. The Wirt Electric Specialty Co., of

Germantown, Pa., has issued bulletin 1106, descriptive of the Dielite resistance unit. Besides describing and illustrating these resistance units, the bulletin gives some space to other specialties, including the Dimalite, and regulating socket. These devices are specially suited to regulating incandescent lamps and very small motors.

ELECTRIC FIXTURES. The Frank Adams Electric Co., of St. Louis, Mo., is distributing a catalogue illustrating designs of fixtures and reflectors manufactured by the company. This company also manufactures an extensive line of standard knife switches, and switch boards for light and power.

ELECTRIC MOTORS. The Star Dynamo Co., of Jefferson City, Mo., has issued a folder descriptive of the direct and alternating current apparatus which they manufacture. The folder shows parts and describes same.

POLYPHASE MOTORS. The Richmond Electric Co., of Richmond, Va., is distributing bulletin No. 14 descriptive of Richmond polyphase motors. This bulletin contains various types of motors manufactured by the company showing application and giving considerable material in regard to sizes and types in which they are manufactured.

PRINTING ATTACHMENT FOR INTEGRATING WATT METERS. The Minerallac Electric Co., of 112 West Adams Street, Chicago, has issued bulletin No. 55, superseding bulletin No. 45, under date of October, 1911, and describing the latest developments in connection with the printometer, an attachment for use with integrating watt meters. This device prints in plain figures on a continuous tape the consumption during every interval as registered on the meter with which it is used. It prints the time in a column parallel to that showing the consumption, thus giving also the accurate time of day and day of week when energy was consumed. This device will be interesting to all central station and mill men. The bulletin is divided into sections, each section taking up the printometer in connection with the following topics: Determining load factor, determining diversity factor, regulating the use of off peak power, determining the use of break down service, complaint work, special tests of power conditions, measurements of speed, and a general description of the instrument.

THE CUTLER-HAMMER MANUFACTURING COMPANY, of Milwaukee, has just published the following new bulletins. No. 10½ describing new multiple switch starting rheostats made in standard sizes from 10 H. P. to 150 H. P., for 110, 220 and 500 volt direct current service. New types of switches are used on these starters. No. 18 describes A. C. squirrel cage primary resistance motor starters made in capacities from 5 to 30 H. P. for 110, 220 and 440-500 volt circuits. Bulletin 2145 describes a new multiple switch starter which, in addition to no-voltage release, is equipped with two new type Cutler-Hammer single pole overload circuit breakers. Standard sizes are the same as for bulletin 10½. The compound multiple switch starter and speed regulator is described in Bulletin 2260. This is made in capacities from 10 to 200 H. P. and combines in one panel starting and regulating rheostats. The apparatus described in Bulletin 2270 is like that of Bulletin 2260 except that main line knife switch and fuses are mounted on the panel so as to facilitate installation. This is called a compound universal motor starter and speed regulator.

TELEPHONE BOOKLET. The Kellog Switchboard & Supply Co., Chicago, has issued a unique postal card booklet, with factory and branch office views, and gives the personnel of the sales representatives. This little booklet, attractively printed in two colors, is a part of an ordinary mailing card and gives views of the factory buildings, mentioning briefly the equipment, the branch offices, with complete stock and shipping facilities. A copy will be mailed on request.

LIGHTING FIXTURES. The Delta-Star Electric Company are distributing a new catalogue, describing a full line of Mazda lighting fixtures for indoor and weatherproof service. Photometric curves are given, by the use of which the proper reflectors can easily be selected for a given installation.

THE WESTERN ELECTRIC CO., of New York City, issued under date of March, 1912, the first number of a monthly publication in the interest of its employes. The publication is to be known as the Western Electric News, and appeared for March in a size 9 x 12 with a cover of good weight, bearing a design in full color representing a phase of life in connection with a large manufacturing establishment. The make-up of the publication is excellent, both in character of material and illustrations. It preserves a balance between the commercial and human interest sides of a large industry from the standpoint of the employee in a dignified manner, and shows the work of a reportorial staff of certainly more than amateurish ability. The departments established cover a wide field of the company's activity and if the publication is continued along these lines, it is sure to gain a permanent place for itself and place the organization among the first in regard to the present movements for industrial advancement.

Alphabetical Index to Advertisers.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

Conduit Boxes.

IRISH ELECTRIC CO., W. F., 60 Cortlandt St., New York City. "Shamrock" cast-iron conduit outlet box for armored cable with removable stud. Approved April 11, 1912.

Conduits, Unlined.

CENTRAL TUBE COMPANY, 35th and Smallman Sts., Pittsburg, Pa. "Central White," "Central Red," and "Central Black" conduit, galvanized and enameled exterior, oxide baked enamel interior. Approved April 3, 1912.

Fixtures.

BENJAMIN ELECTRIC MFG. CO., 120-128 S. Sangano St., Chicago, Ill. Tungsten arcs, indoor and weatherproof forms; ceiling fixtures; reflector socket fixtures; Mazda series connected cluster, for use with four low voltage standard Edison base lamps. Approved April 11, 1912.

CASSIDY AND SON, 133-135 West 23d St., New York City. Electric and combination fixtures. Approved April 3, 1912.

ENOS COMPANY, 7th Ave. and 16th St., New York City. Standard electric and combination fixtures. Approved April 16, 1912.

ROYAL ART GLASS CO., 243 Canal St., New York City. Standard electric fixtures. Approved April 4, 1912.

FRINK, I. P., 24th St. and 10th Ave., New York City. "Frink" electric and combination fixtures; show case and window reflectors; "linolyte" fixtures; portable and picture reflectors. Approved April 16, 1912.

LAWRENCE GAS FIXTURE MFG. CO., 1334-1338 Arch St., Philadelphia, Pa., standard electric and combination fixtures. Approved April 12, 1912.

WILLIAMSON CO., L. A., 258 Broadway, New York City. "Flexilyte" portable one-light incandescent lamp fixture with a length of flexible cord and an attachment plug. Cord wound on drum, the base of which forms supporting base of lamp receptacle. Approved April 18, 1912.

Flexible Cord.

AMERICAN STEEL AND WIRE CO., Worcester, Mass. Marking: Soft woolen thread on rubber surface lengthwise of wire under braid N. E. Code 1911. Approved Apri 8, 1912.

AMERICAN ELECTRICAL WORKS, Providence, R. I. Marking: Yellow thread cabled with the copper strands. Approved April 9, 1912.

BOSTON INSULATED WIRE & CABLE CO., Dorchester District, Boston, Mass. Marking: One coarse uncolored thread woven in braid in a counter clockwise direction. Approved April 18, 1912.

BISHOP GUTTA-PERCHA CO., 420 E. 25th St., New York City. Marking: One green cotton thread running parallel with wire between the rubber insulation and braid. N. E. Code 1911. proved April 8, 1912.

DETROIT INSULATED WIRE CO., Wesson Ave. and Albert St., Detroit, Mich. Marking: One red thread in the cotton wind. N. E. Code 1911. Approved April 8, 1912.

ELECTRIC CABLE CO., Bridgeport, Conn. Marking: One white thread cabled with copper strands. N. E. Code 1911. Approved Apri 8, 1912.

GENERAL ELECTRIC COMPANY., Schenectady, N. Y. Marking: Green threads in cotton wind around copper strands. N. E. Code 1911. Approved April 8, 1912.

GOODYEAR RUBBER INSULATING CO., 155 East 131st St., New York City. Marking: One red and two green threads cabled with copper strands. N. E. Code 1911. Approved April 9, 1912.

INDIANA RUBBER AND INSULATED WIRE CO., Jonesboro, Ind. Marking: One black thread in cotton wind. N. E. Code 1911. Approved April 9, 1912.

MARION INSULATED WIRE CO., Marion, Ind. Marking: One blue thread cabled with copper strand. N. E. Code 1911. Approved April 9, 1912.

MOORE, ALFRED F., 200 N. Third St., Philadelphia, Pa. Marking: Red, white and blue cotton thread cabled with copper strands. N. E. Code 1911. Approved April 9, 1912.

NATIONAL INDIA RUBBER CO., Bristol, R. I. Marking: Two blue threads cabled with copper strands. N. E. Code 1911. Approved April 9, 1912.

OKONITE CO., LTD., 253 Broadway, New York City. Marking: Ridge on Rubber insulation. N. E. Code 1911. Approved April 9, 1912.

ROEBLING'S SONS CO., JOHN A., Trenton, N. J. Marking: One blue thread parallel with the cord under braid. N. E. Code 1911. Approved April 9, 1912.

ROME WIRE CO., Rome, N. Y. Marking: One yellow and one green thread together, laid parallel with conductor between rubber insulation and braid. N. E. Code 1911. Approved April 9, 1912.

SAFETY INSULATED WIRE AND CABLE CO., 114 Liberty St., New York City. Marking: Yellow thread in cotton wired around copper strand. N. E. Code 1911. Approved April 9, 1912.

SIMPLEX ELECTRICAL CO., 201 Devonshire St., Boston, Mass. Marking: One red thread parallel with conductor between rubber insulation and braid. N. E. Code 1911. Approved April 9, 1912.

STANDARD UNDERGROUND CABLE CO., Westinghouse Bldg., Pittsburg, Pa. Marking: Brown thread cabled with copper strand. N. E. Code 1911. Approved April 9, 1912.

WATERBURY COMPANY, 80 South St., New York City. Marking: Two black threads running parallel with the wire between rubber insulation and the braid. N. E. Code 1911. Approved April 9, 1912.

Panel Boards.

ALMSTEAD MFG. CO., 183-187 N. Water St., Rochester, N. Y. Two and three-wire panel boards, 125, 125-250, and 250 volts, with double knife switches in branch circuit with or without open link or cartridge enclosed fuses. Approved April 4, 1912.

CARSTARPHEN ELECTRIC COMPANY, Colfax and Broadway, Denver, Colo. Two-wire 125 and 250-volt and three-wire 125-250 volt, with or without main line and branch circuit switches. Cartridge enclosed or plug fuses in branch circuits. Approved April 4, 1912.

Wires, Rubber—Covered.

AMERICAN ELECTRICAL WORKS, Providence, R. I. Marking: Three red threads woven parallel in braid block case. N. E. Code 1911. Approved April 3, 1912.

BAY STATE INSULATED WIRE AND CABLE CO., River St., Hyde Park, Mass. Marking: One black thread running parallel with wire between rubber insulation and braid. N. E. Code 1911. Approved April 3, 1912.

CRESCENT INSULATED WIRE AND CABLE CO., Trenton, N. J. Marking: Red and blue threads crossing in braid. N. E. Code 1911. Approved April 3, 1912.

PHILLIPS INSULATED WIRE CO., Pawtucket, R. I. Marking: Two black strands woven parallel in braid. N. E. Code 1911. Approved April 3, 1912.

ACME RUBBER MFG. CO., Trenton, N. J. Marking: Two red threads woven into braid crossing each other. Approved April 25, 1912.

BOSTON INSULATED WIRE & CABLE CO., Dorchester District, Boston, Mass. Marking: Blue threads in cotton wind around copper strands in a counter clockwise direction. Approved April 18, 1912.

COLLYER-INSULATED WIRE CO., Pawtucket, R. I. Marking: Two blue threads crossing in braid. Approved April 26, 1912.

GOOD YEAR RUBBER INSULATING CO., 105 E. 131st St., New York City. Marking: Two green and one red threads woven parallel in braid. Approved April 22, 1912.

HOME RUBBER CO., Trenton, N. J. Marking: Three red threads crossing in braid. Approved April 27, 1912.

SOUTHERN ELECTRICIAN

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CONTENTS.

Residential Rates.

Unquestionably there is no one thing so vitally connected with central station new business getting as the price demanded for the service rendered. The extent to which electric service is to be used therefore depends upon the general level of charges made, and in general the lower this level the broader will be the field of application. This is the aim of the average present day station for with a broader field of application comes a more diversified use, a better station load factor, and a lower unit cost of production. On account of these facts, it is now plain that to get the most out of a given field of service, the general level of charges for any given service must be adjusted automatically by the rate, so as not to exceed the customer's estimate of the value of electricity for such service. It is generally agreed that at 20 cents a kilowatt hour on a straight meter rate, electricity at the present time would find a limited field of use for lighting, for with all its conveniences a great many customers might not consider electric light worth the price demanded and hence other illuminants would be in more general use. At 15 cents the use might be extended somewhat but for practically no other purpose than lighting there would still be a poor station load factor. At 10 cents electricity may in some cases be fairly generally used for lighting and perhaps a few electric irons placed in service. However, although electricity can compete with other illuminants at a rate of 10 cents per unit especially if the new lamps of high efficiency are utilized, it is a question if much application for anything but lighting can be hoped for. When, however, a slight lowering still is made and a rate of say 10 cents per unit made for the energy ordinarily used for lighting during the time of the station's peak, and a lower rate of perhaps, 6 cents made to the lighting customers for all the additional electricity consumed, it has been found that the use of electric irons, heating, cooking and other appliances begins to figure and be encouraged, the sale of electricity increases, the load factor of the station improves, the customer gets more for his money, the net profit from operation rises and the public service company begins to realize its prime desire.

Simple ways for bringing about these conditions on a large scale and developing a day load on residential circuits, have been suggested, discussed, and placed in use with varying degrees of success. Today the multiple rate carrying primary and secondary charges per Kwhr is looked upon with growing favor for residential service. Under such a rate the customer pays for all energy consumed each month up to a certain amount, depending upon the size of his installation, at a primary rate of perhaps 10 or 12 cents per Kwhr. All energy used in excess of this amount is paid for at a rate about half as great. In the past the number of units to which the primary rate was made to apply in any particular case was estimated from the connected lighting load, either by counting the actual wattage of the lamps connected or more commonly by allowing a fixed wattage per socket. Heating, cooking and other devices were not counted as a rule to increase the rating, based en-

tirely on the lighting demand. Complicated rules as to what percentage of the installation should be counted as 50-watt equivalents and what percentage at 25 watt, together with allowances for decorative and convenience lights and considerations of ratio between connected load and maximum demand have consequently grown up around such rates. In spite of the complicated methods of figuring the number of primary units, such differential rates have shown themselves to be immeasurably better than the straight meter rates carrying a single fixed charge per unit.

Elsewhere in this issue we present an abstract of a paper delivered at the convention of the Mississippi Electric Association by Mr. G. S. Merrill, a rate expert for the National Electric Lamp Association. In this discussion the details of a rather novel development are taken up. This development is however, one which has now been in actual use by a few stations for several years and one possessing many features of decided interest. It is in the main a method which uses illuminated area or number of rooms in the residence, as a basis for determining the number of units to which the primary rate will apply. Where this system has been used it has worked out satisfactorily and has served to distribute the burden of fixed charges equitably between different customers with due consideration of both the cost and the value of the service rendered. The exact manner in which the rate may be put into effect will naturally depend upon the habits and character of the community served and is a matter for local consideration. If a room basis is used it is probable that some limiting area should be established above which extra requirements would be made, and possibly as a matter of self-protection, the central station should reserve the right to install a current limiting device or demand meter on any customer's circuit in case abnormal demands should be placed upon the plant. In these events the number of units to be used at the primary rate would be established from the electrical demand rather than on the floor area or number of rooms.

In any case one great advantage of a rate using the number of rooms or floor area as a basis for calculation, is that it is more intelligible to the ordinary customer than almost any sort of a rate bringing in estimates of demand based on wattage. There is very little chance for argument about the rating of any individual consumer, particularly where the room basis is used.

This form of rate is used today in one Canadian city where it has proved a success in every way, being both satisfactory to the customer, and securing for the station a large volume of business. Besides being as simple as could be desired, it opens up a most attractive field for the use of all kinds of current consuming devices, and makes it possible for the consumer to secure much more in the way of service from the station for very little additional expense. No station is too small to give this very important matter its serious thought if it intends to get the maximum return from its residential business by the commendable method of giving the customer the most for his money.

To 1912 Technical Graduates.

The engineering schools throughout the country have graduated during the past month hundreds of prospective electrical engineers. These men can at this time be generally divided into two classes, those who have decided upon their line of future activity and have already secured positions and those who have not and are looking for the position that will pay the most money at the start. Of these classes the latter is the largest in numbers, and strange as it may seem produces engineers in many cases of as high calibre as the former.

The graduate who finds himself in the last named class should not deplore his state of non-employment or inability to decide upon his particular line of electrical work, for most young engineers do not fully realize their particular capabilities and waste valuable time in misapplying themselves. There are of course exceptions, especially in those cases where considerable practical experience has been secured before and during the college course. In general however, the student is entirely unfamiliar with the ramifications of the electrical industry and has spent four years in a technical school absorbing the fundamentals of the many branches of work. In so far as he has absorbed these fundamentals in a thorough and general way just in that proportion will his progress be rapid in actual practice. No one technical graduate has any advantage over another except in this point. While there may be an exceptional case where parental influence paves the way at first, yet the engineering ability of such a one when put to the test is not above the one who after graduation finds himself lost in identity and a pair of overalls among an army of workers all apparently wiser than he, yet not older in years.

The large plant that has prctical instruction courses open to young graduates is the school for the technical man who desires a real and tangible knowledge of engineering and a fertile field to place his absorption of fundamentals, where it will grow to maturity and be pruned and trained by the laws that govern design, manufacture, construction and erection, not found in text books and of which he has now only a mental picture. With sufficient training in this school, the young engineer can then decide what he does not want to pursue and is in the profession of an engineer many times better equipped than his seemingly more fortunate brother who has escaped the apparent hardship through other means and has an apparently desirable position.

To the man who has a desire for the best possible foundation upon which to build a successful engineering career, we advise by all means to apply for a position in one of the apprenticeships courses now open to him. Stay with this course to the end even at an existance wage, it will provide a profitable return later. To the average graduate who has heard much about the specialist, this may seem foreign advice, however, if an investigation is made, it will be found that the specialist in electrical engineering today is in fact a generalist and has a good working knowledge of many subjects. Knowing everything about something and something about everything should be a motto from the start. A year may pass in the apprenticeship course, it may be finished and no particular line of work suggest itself. If this be the case, well and good, nothing has been lost and much has been gained, the engineering field is yet to be entered, or design or construction. The time spent and knowledge gained at the end of the course, combined with the information absorbed during the college course, begins to have a value in dollars per week or per month, the engineering career is just opening and with ideals high, much hard work and a capitalization of ability moderate, a good engineer usually will result.

The Seattle Convention of National Electric Light Association.

(*Reported for* Southern Electrician.)

BY W. ERNEST CROSBY.

THE first N. E. L. A. Convention on the Pacific Coast and the 35th of the Association fulfilled every expectation and the lingering impressions now refer to a most cordial welcome, the usual successful accomplishment of much convention work and a hospitality extended by Seattle people and the Puget Sound Traction Light & Power Co., that has set a strenuous pace for future convention cities. In point of attendance the record for last year stands, yet a registration of 1,500 at the closing session, certainly speaks loudly for the position the Association occupied in the business minds of central station men in the western part of the United States as well as in the eastern. This attendance was most representative, the gathering being made up of those from the North, East, South and many from the West, the latter taking this opportunity to learn what the material activities of the association are like. To many of the men a new light has appeared and the N. E. L. A. will actually mean to them what it never has before, a power in influence and activity in the central station industry.

Frank M. Tait,
President of N. E. L. A., and President Dayton Power & Light Co.

The State Armory as the convention headquarters, was so transfigured during the four days with brilliant lights and the usual N. E. L. A. decorations as to bring forth much comment from the local visitors and members. The decoration effects about the exhibition booths were in white and gold with a canopy of cream and garnet hanging from the roof trusses above. From this canopy, in an artistic arrangement, was suspended art glass chandeliers and clusters of incandescent lamps in such a manner as to give an effect of dazzling brilliancy. The booths were arranged about the walls of the exhibition hall, with six sections occupying the central portion of the area. These six sections formed a rectangle in outline, on each corner of which was arranged four booths. On each of the long sides, eight more booths were arranged between the end sections of the four booths, making in all 32 central booths and 37 wall booths. As usual the booths were constructed along distinct lines with the exhibitors names displayed in gold letters and the upper frame work studded with concealed incandescent lamps which illuminated the lettering. The general effect is shown in the photograph on page 281.

The principal events of Monday, the first day of the convention, were the arrival of the various delegations, the reception and the grand ball at the Armory. The latter was a distinct feature for which special preparations were made in honor of President and Mrs. Gilchrist, this function being an official reception and a feature of every convention. The reception and ball was held in the main assembly room the walls of which were covered with drapery and banked with Washington firs, the spaces between being completely filled with a profusion of all the flowers of the Evergreen state, such as roses, rhododendrons and Shasta daisies, making the room a veritable wonderland bower.

The north promenade of the armory was transformed from a walk of concrete hedged by the brick walls, to a wonderful conservatory with soft carpets and lounging chairs, the walls banked with fir trees and flowers and the whole lighted with electric lights concealed in colored Japanese lanterns. Punch and refreshments were served outside and the cool lounging place with a commanding view of Elliott Bay brought many remarks of admiration from the visiting guests. Music was provided by an orchestra.

The first real work of the convention formally started when President John F. Gilchrist introduced Hon. G. F. Cotterill, Mayor of the City of Seattle, on Tuesday morning at 10 o'clock and the usual welcoming address was given. In this report we will not follow the actual order of events at the convention, after giving the following account of the first general session. The report will be made up of an account of the general sessions altogether, the technical sessions, power transmission sessions, the commercial sessions, the accounting sessions, the public policy sessions and the company section sessions all together, after the general plan outlined in the June convention issue of Southern Electrician.

General Sessions.

Mayor Cotterill in his welcoming address, which formerly opened the convention, reviewed the rapid growth of the city of Seattle, showing how its commercial activity has been connected with the electrical development of the section. He placed Seattle at the head of the list of America's brilliantly lighted cities, and gave statistics to show that it merits this position. He stated that there are in operation in Seattle 1,631 tungsten cluster posts, and 25 miles of streets illuminated by 8,000 incandescent lamps. His words of welcome were most hearty and cordial. President Gilchrist responded to the Mayor's address in fitting terms which together with the loud applause was ample indication of the appreciation felt by the members and guests.

President Gilchrist's Address.

Following this response President Gilchrist surrendered

the chair to Vice-President Tait and delivered his presidential address. This address was remarkable for the amount of information which it contained and an abstract of it can do it little justice. He carefully outlined the work of the past year in the central station field and the part the association has played in this work. He contrasted the methods which the association now follow in carrying on its activity with those of a few years ago when such activity was limited to a few months prior to the annual convention. At the present time the work is continuous through standing committees and the paper which formerly predominated and was prepared by the individual has now been replaced by similar information conveyed by the report of a committee. The character of the reports presented at this convention is sufficient indication of the logic of these plans.

JOHN F. GILCHRIST, Retiring President.

He reported a favorable growth in membership stating that an effort should be made to increase the Class A membership both among large and small companies as the association offers most to this class of membership. He mentioned the authorization of the employment of an assistant to Secretary T. C. Martin which position will be filled by H. B. Seawall of the Puducah Light & Power Co., of Paducah, Ky. This will permit Secretary Martin to devote more time to visiting the meetings of geographical and other affiliated bodies and will result in closer touch between these bodies. Much is expected from this arrangement as Secretary Martin is endowed with particular qualifications to bring about many new developments from this standpoint. In regard to the question box, he felt that an increased appropriation could be profitably set aside for the work and predicted that on account of the growing importance of it and the work which it entails, the handling of it after the coming year will be forced upon the duties of the secretary's office.

The affiliation of state sections has been slow yet promising and it is evident that the work which has been done by the state associations points to a carrying on of the scientific work of the association through these associations at their conventions enabling the National organization to become more of an executive nature composed chiefly of regularly constituted delegates from the affiliated associations. Some form of association between company sections and state sections was also suggested.

President Gilchrist was of the opinion that the associations annual income of something like $100,000 is not adequate for he believes that the association should have a reserve fund of at least $500,000. The association now has a reserve fund of $15,000 started sometime ago and it is desirable that this be increased. He further advocated the desirability of the association having a building of its own located at the center of population from the viewpoint of the entire membership.

He advocated that the association should maintain an attitude of cordial and friendly co-operation in assisting the various public service commissions to arrive at conclusions that are right and fair and that the association should promote harmony and good feeling among all of the interests in the electrical industry.

In regard to municipal ownership, President Gilchrist believes that the association has important work to do and voiced the sentiments that the country would receive better service rendered at the same price or the same service at a lower price in all branches of public utility work by privately owned enterprises. He commented upon the deplorable lack of uniformity in the schedules of rates in various parts of the country and believes that the time is close at hand when uniform rate systems must be put into effect.

In his concluding remarks President Gilchrist urged the promotion of broad and fair relations between public utility companies and the public. From the standpoint of the association he said, "If this association can hasten the adoption of broad and intelligent policies in the conduct of the business of all its member companies, it will have accomplished a work of sufficient importance to the success of the business, to have paid for its existance if it never accomplishes anything else. "According to custom the president's address was submitted for consideration and future report.

After the president's address, Mr. J. A. Britton of the Pacific Gas & Electric Co., of San Francisco, Cal., made an interesting address in which he invited the association to hold the convention in San Francisco in 1915, at the time of the Panama-Pacific Exposition.

The next order of business was announcements by Secretary Martin followed by a report of the committee on organization of the industry. This report was presented by H. H. Scott of the Doherty Organization, New York and gave interesting date as to the present status of the organization. According to this report the membership stands at 12,084 and is made up of the following members. Class A. 1,134; Class . 9,725; Class C. 45; Class D. 240; Class E. 940. During the passed year the membership has increased by 3,419 made up chiefly of Class B members, this class of membership having increased by 3,071. During the year three geographical sections and nine new company sections have affiliated with the National body, making all told ten geographical sections and 37 company sections.

The report of the insurance expert, presented by W. H. Blood, Jr., of the Stone & Webster Corporation of Boston covered the progress during the past year. It showed that the fire Underwriters are giving more attention to the scientific rating of central stations and that operating

companies are observing the Underwriters requirements more carefully. Liability insurance is yet in an undeveloped state. The grounding of secondaries and the new specifications for rubber covered wire recently effective were commented upon.

Secretary T. C. Martin's report on progress was next given and was prepared this year in two parts, the first dealing with general progress and the second with power transmission. The report was of the usual comprehensive nature going into all phases of progress fully and taking up the following topics: General growth, foreign comparisons, regulations and rates, municipal ownership and private competition, new stations and plants, general questions of illumination, electricity and agriculture, the larger uses of current, miscellaneous uses of current, general relation with the customers, and relations with employees. It showed the total number of central stations at the beginning of this year to be over 6,400 and that the central station fiield is generally expanded.

The report on the question box by the editor, Earnest A. Edkins of the Commonwealth Edison Co., showed that during the 11 years of its existance 3,958 questions and 15,189 answers had been exchanged. The demands upon the time of the editors are constantly increasing and the permanent editorial staff now arranged for will enable the presentation of the material in somewhat more brief form. The discussion following the reading of this report emphasized the importance of the question box and its great usefulness to the industry.

A paper on expanded Loyalty by Paul Lupke, of the Public Service Electric Co., of Trenton, N. J., took up interesting phases of loyalty and stated that loyalty implies a worth object as well as that faithful interest which is commonly associated with the quality itself. The idea expressed was that no man with a right spirit is afraid to let others see that he gives more than full measure for what he receives and that one must first be worth more to receive more. This closed the work of the first general session.

SECOND GENERAL SESSION.

The second general session was held Wednesday morning with President Gilchrist presiding and opened with the report of the rate research committee by E. W. Lloyd of the Commonwealth Edison Co., of Chicago. The report reviewed the large amount of work done by the committee and submitted recommendations for collecting rate information, appointing member companies assistants to the committee, distributing the rate research bulletin and adopting uniform methods of charging. The committee recommended that either a demand basis or a straight line meter charge be adopted for small business and the demand charge for large business. Uniform systems of charging throughout the country were urged as necessary. The report contained a glossary of rate terms and many sample forms which member companies are recommended to employ in filing their schedules with the committee.

The discussion of the report was prolonged and the many features discussed at length. In fact the report took up the entire time of the session and the other papers scheduled were read by title or postponed for reading at a later session. An abstract of the papers which were to be presented however, are as follows:

A paper was offered on the desirability as a central station load of pumping for municipally owned water works, by Charges A. Monroe of the Public Service Co., of Northern, Illinois, Chicago. This paper gave in condense form the reasons why municipal pumping is a good load for the central station. It was shown that the average energy required to deliver 1000 gallons is about 2½ Kw., and also stated that the business is not only a desirable off peak one but important to forestall the establishing of central station competition by combining an electric plant with the steam driven municipally owned water works. The author recommended a contract to be made on a Kw. hour basis instead of charging a given rate per gallon so as not to become responsible for the delivery of water in addition to electrical energy.

After the close of the discussion on the rate question, the association went into its executive session at noon and adopted the report of the public policy committee. Mr. Samuel Insull was chosen to read the report at the evening meeting. F. W. Frueuaff presented a number of constitutional amendments which were referred to an elected committee, reporting at a future session. The nominating committee was also elected at this executive session. The members of this committee were Messrs. Samuel Insull of Chicago, H. L. Doherty, of New York. H. T. Edgar of Seattle, J. E. Montague of Niagara Falls, N. Y. and M. Hart, of New Orleans.

THIRD GENERAL SESSION.

The third general and executive session was held Thursday afternoon and opened by the reading of Dr. W. R. Whitney's paper on, Some Uses of Metals by Charles W. Stone, of the General Electric Co. This paper showed how far modern research has carried the electrical industry beyond the limitations of the two principal metals upon which it was founded, copper and iron. Recent improvements in the electric furnace have made much higher temperatures available and the results of the researches which will be carried on in the immediate future may be waited with interest.

The next subject, namely, the report of the committee on street lighting was presented by John W. Lieb of the New York Edison Co. This report reviewed briefly the history of the development of street lighting equipment and discussed the present situation noting the tendency of luminous and flame arcs to replace the earlier alternating current series enclosed arcs and a further tendency to the adoption of tungsten filament lamps. The committee pointed out that an investigation of street lighting should take into consideration, character of street pavements and surroundings, spacing, location, and heights of lamps, and the character of the globes reflectors, etc., the intensity of the illumination, distribution characteristics, steadiness, glare and color.

Mr. H. H. Scott, of New York, read the report of the committee on constitutional amendment in the absence of Mr. F. W. Frueauff, the chairman.

The committee on the president's address entered a report endorsing the recommendations of the President relative to the growth of membership, the appointment of a traveling representative, the increase in the number of vice-presidents as well as the increase in the dues of member companies.

The committee on memorials presented briefly sketches of men who had died during the year and who had been actively connected with the work of the association or active in the central station industry. This report was presented by Secretary Martin.

The committee on resolutions rendered a report giving the names of those to whom the association was indebted for many courtesies. Among those mentioned was the Puget Sound Traction Light & Power Co.; McGraw Publishing Co., for the work on the Convention Daily; The local and technical press; the Mayor of the City and the people of Seattle in general for hospitality.

The nominating committee recommended the following as officers and they were elected for the ensuing year. President, Frank M. Tait, of the Dayton Power & Light Co., of Dayton, Ohio; first vice-president J. B. McCall of the Philadelphia Electric Co., Philadelphia, Pa.; second vice-president H. H. Scott, of the Montgomery Light & Water Power Co., of New York.; treasurer, W. W. Freeman of the Edison Electric Illuminating Co., of Brooklyn, N. Y.; Members of the executive committee for three years, Messrs J. A. Britton, of San Francisco; C. E. Groesbeck, of San Diego, Calif.; and C. A. Stone, of Boston, Mass.; Member of the executive committee for one year succeeding Mr. Scott who was elected second vice-president, R. S. Orr, of Pittsburg, Pa.

The New N. E. L .A. President.

In electing Frank Morrison Tait as president of the National Electric Light Association for 1912 and 13 the association has followed the rule of previous years to advance its first vice president to its highest office. The body has now the governing influence of one of the youngest central station executives in the industry, yet one of the most representative and a man who has the welfare of the N. E. L. A. and the central station business thoroughly at heart. He has been connected with the association for a number of years, first as a member of the executive committee, later as secretary and treasurer, then as second vice-president and last year as first vice-president. He has not only been active in N. E. L. A. work but has read papers before the Electrical Vehicle Association of America, and was also a member and later chairman of the electric vehicle committee of the Edison Association of Illuminating Companies. He has taken a prominent part in the affairs of the Ohio Electric Light Association, and is now one of three men constituting the advisory board of that association, having to do with matters effecting the public policy of the Ohio companies.

The central station career of Mr. Tait while brief has been most strenuous. In 1894, when 20 years of age, he began as an electric service operator, by becoming manager of the Catasauqua Electric Light & Power Co., this company he directed until 1899 when he became connected with the public utility company of Somerville, N. J., and rebuilt all of the plants at that place which were merged under the name of the Somerset Lighting Co. This corporation and its equipment now forms a part of the extensive system of the Public Service Corporation of New Jersey. Mr. Tait then directed his activities in New London, Conn., where he took charge of the gas and electric properties of the company now known as the New London Gas & Electric Co. In 1905 he removed to Dayton, Ohio, to take charge of the Dayton Electric Light Co., representing the interests of A. M. Young and A. N. Brady, of New York City. The company is now known as the Dayton Power & Light Co., and in addition to being the president and manager of this company Mr. Tait is Vice-President of the Xenia Gas & Electric Co., of Xenia, Ohio.

Technical Sessions.

The first technical session was opened Tuesday afternoon with W. C. L. Eglin, of Philadelphia, in the chair. The first business was the presentation of the report of the committee on electrical measurement and values by Dr. A. E. Kennelly, of Harvard University. The report was read by J. W. Howell, of Newark, N. J., and described the change of the standard of candle power on July 1, 1909 and the change in the international standard volt on January 1, 1911. It is stated that these changes went into effect at the Electrical Testing Laboratory at New York without any difficulty or serious inconvenience.

The discussion brought out the hope that a future international electrical congress will ratify the slight changes in candlepower and voltage standards which have already been sanctioned by the National Bureau of Standards and adopted by the United States and other countries. It was shown that the effect of these changes however are quite negligible from a commercial standpoint but not invariably so. A written report by Dr. C. H. Sharp, of New York, presented comparative tables illustrating the effect of these changes in standards.

A paper on "The Proper Lamp for a Circuit" was next presented in abstract by R. E. Campbell, of the National Electric Lamp Association. The report dealt with the proper selection of incandescent lamp for central station service. Four fundamental considerations from the consumer's standpoint were pointed out, namely, desired intensity of illumination, proper quality of light, minimum fluctuation of intensity, and maximum economy. The line voltage was stated as the key to the situation and the matter of voltage regulation as well as the proper type of lamp for a given voltage are each important. The report presented material from central stations working in a population from 1,500 to 15,000 and the results represent conditions from 82 central stations systems."

The report of the lamp committee was presented by F. W. Smith, of the United Light & Power Co., of New York. The report covered the data on lamp sales during the past year and stated that approximately 85,000,000 domestic lamps of standard types were sold during 1911, an increase of 8.45 per cent over 1910. An interesting table showed the distribution of sales among different class of lamps during the past five years. Carbon lamps have diminished to 52.9 per cent of the total for 1911 and in 1912 will probably not exceed 20 per cent of the total. Gem lamps are slowly increasing in sales reaching 19 per cent of the total. in 1911. The committee recommends the Gem or metalized filament lamp as a substitute for the carbon lamp by all member companies. Tungsten lamp sales have increased year by year and in 1911 amounted to 25.36 per cent of the total. The committee recommended particularly to member companies that a broad and liberal policy be introduced for the introduction of tungsten filament lamps to customers.

In the discussion it was pointed out that very large sizes of tungsten filament lamps are satisfactorily replacing many of the early series arc lights for street illumination and that the very small sizes of tungsten lamps have been used with notable success in sign lighting. It was stated further that on account of recent improvements, increasing the durability of the tungsten filament, the lamp companies have decided to abandon the practice of shipping tungsten lamps in cotton packing.

A paper on meter installation was next presented by D.

Corbet of Seattle in absence of the author, S. D. Sprong, of the Edison Electric Illuminating Co., of Brooklyn. Mr. Sprong took up the commercial aspects of the problem with special reference to the small customers. He presented a table showing the distribution of 35,000 meters among installations of different sizes. Five-ampere meters made up 58.8 per cent of the whole, 10 ampere meters amounted to 20.3 per cent and meters with a capacity ranging from 10 to 25 amperes amounted to 14 per cent. He showed that the average cost of the small meter alone is $15 and the average cost of installation $13, making the total investment $28. The corresponding annual charges are $3.40. He mentioned the fact that a problem demanding serious attention is the development of cheaper metering devices for small customers. He further pointed out that the advent of lamps of still higher efficiency may make it economical in small installations to serve the customers on a flat charge per lamp basis.

Electrical Meterman's Handbook. Much discussion arose over the cheaper type of watt meter which particularly referred to the proposed use of an ampere-hour-meter for direct current installation for the very large class of customers whose annual consumption is minimum. There seems to be some doubt that an ampere-hour-meter for direct current work would form a sufficiently accurate basis for service charges in modern plants where regulation is good. There was some discussion in reference to the relative merits of the two-point and the three-point methods of testing meters, it being pointed out that the three-point method did not consume much more time than the two-point method.

The report of the committee on grounding secondaries was presented by W. H. Blood, Jr., in which it was recommended that secondary alternating-current circuits carrying not more than 150 volts, should invariably be grounded. The report called attention to the discussions on this question and the New York conference in March 1912 when it

Fig. 1. A View of the Exhibit Hall at Seattle State Armory.

In the discussion one speaker pointed out that the most satisfactory basis of comparing meter installation cost is to reduce the cost to a killowatt-hour basis. It was also pointed out that current limiting devices are sometimes used to cheapen the customers' meter installation which practice is not universally approved by public service commissions, the Ohio Public Service Commission being named.

The report of the committee on meters was next presented by O. J. Bushnell of the Commonwealth Edison Co. The committee commented upon existing difficulties in securing properly trained meter men, thus making it necessary for a hand book which would deal with meter matters in a simple, practical way. The committee has given attention during the past year to standardization of meter designs and has secured the consent of several manufacturers to adopt a simple design form of meter dial plates. The need of a much cheaper meter for very small customers was pointed out.

The discussion voiced appreciation of the excellent and comprehensive work of the committee in preparing the

was recommended to make the changes in the National Electrical Code.

The discussion voiced an appreciation of the work of the committee during the past five years and the report was referred to the executive session with the recommendation that it be received and get the final indorsement of the association as a whole.

SECOND TECHNICAL SESSION.

The second technical session was opened Wednesday morning with F. M. Tait, of Dayton, presiding. The first business was the report of the committee on terminology presented by Chairman W. H. Gardner, of New York.

Certain terms and definitions relating to central station business were defined including "capacity," "demand," "load," and "diversity factor." The 'watt-hour-meter" as applied to an instrument registering "watt-hours" was recommended in place of the term "indicating watt-meter" or "recording wattmeter" now used. Definitions were presented covering, "flat rate," "demand rate," "meter rate" "two charge rate," etc. The discussion voiced the approval of the definitions presented.

A paper on, New Current Consuming Devices by F. N. Jewett, of the Wagner Electric & Mfg. Co., of St. Louis was next presented. This paper took up single phase converters and rectifiers adapted to charging electric vehicle batteries and for other uses, such as moving picture and theatrical work, telegraph systems and railway signals. The discussion following the paper brought out the fact that the type of rectifier described was originally designed to operate on 60 cycles but will be placed on the market in types suitable for operation on frequencies from 25 up to 60.

A paper on 24 hour service in small central stations was next presented by G. R. Murphy in absence of the author, Taliaferro Milton of the Electric Storage Battery Co., of Philadelphia, Pa. The paper took up in the main the possibilities in the use of storage batteries and considered under three heads, new plants where a sufficient number of possible customers cannot be obtained without 24 hour service; where in existing plants the enauguration of a 24 hour service would secure additional customers and third in plants where 24 hour service would improve the quality of service and the increased returns, more than offset the charges on the additional investment. Numerous examples were cited. The discussion was taken up by a number present and the advisability of the installation of a battery and direct current service discussed for adoption in a small station.

The work of the committee on overhead line construction was next presented by Farley Osgood of the Public Service Electric Co., of Newark, N. J. A formal report was not presented at this convention. A very complete report presented by the committee at the 1911 convention was carefully considered by the legal council of the association and in December last the executive committee formally approved it for the association. Additions will be made by the various other associations interested and the entire report will come up for final report at an executive meeting of the American Railway association held in the fall. Mr. Osgood explained a few of the sections which are under discussion and to which additions have been made. The report was briefly discussed.

THIRD TECHNICAL SESSION.

The last technical session was called to order by President Gilchrist Thursday morning. The first business was the report of the committee on prime movers, which was read by J. M. Krumpp in the absence of the chairman I. E. Moultrop, of Boston. This report covered very thoroughly the progress made during the year in connection with prime movers for use with water, steam, and gas power. Several advantages of purchasing coal on an ash basis was pointed out. Attention was also called to the very high efficiency of small reciprocating engine units now employed abroad, such as the Wolfe, Lenz, and Locomobile types. Mention was made of the possibilities of developing gas turbines from utilizing the waste heat from gas and oil engines. The discussion of this report was spirited and a number of those present took part. The operation of boilers was thoroughly discussed and particular reference was made to the quantity of steam required for vaporizing fuel oil in oil burning installations. It was pointed out that in Southern California, only two per cent to two and a half per cent of the total steam production is required for oil vaporization.

The report of the committee on electrical apparatus was next presented by the chairman, L. L. Elden, of the Edison Electrical Illuminating Co., of Boston. This report covered progress made during the year in generating station and substation aparatus. The committee pointed out that the demand for better steam turbine economy had resulted in the use of higher speeds, especially on medium and large size units. It was pointed out also that it is desirable to adopt 60 cycles as standard frequency for synchronous converters. Mr. C. W. Stone, of Schenectady, discussed the report completely.

Following the report on electrical apparatus, S. B. Way, of Milwaukee, a member of the committee presented the report of the committee on underground construction in the absence of the chairman, W. L. Abbott, of the Commonwealth Edison Co. This report took up the following topics, alternating current underground distribution, man hole construction, electrolysis, and high tension cable data and specifications. There is an increasing tendency on the part of cities to require the placing of distributing systems underground in residential districts. Important work of the committee included the material relating to electrolysis. The prevention of electrolysis was discussed under the following headings. Double trolley system, negative return feeders, three-wire trolley systems, parallel circuit system, insulated cable joints, water proof conduit system, insulated cable joints, water proof conduit systems, and the drainage system. The discussion brought out the fact that investigation should be made to determine the safe temperature limits at which underground cables can be operated. It was pointed out that fibre or wooden ducts are valuable in protecting cable sheaths from mechanical injury and electrolysis.

A paper was presented on the care and operation of transformers by S. Q. Hayes of East Pittsburg, Pa., in the absence of the author W. M. McConahey, of East Pittsburg. The paper gave a synopsis of the important precautions to be observed in erecting and maintaining large transformers for high tension service. About half of the paper was devoted to a discussion of the proper methods of connecting two or more transformers in parallel or in banks on polyphase circuits illustrated by numerous potential diagrams.

Power Transmission Sessions.

The first session of the power transmission section was held Tuesday evening at 9:00 p. m. with Chairman H. L. Doherty, of the H. L. Doherty and Co., of New York, presiding. The first matter taken up was the address of the chairman and W. H. Blood, Jr., presided while Mr. Doherty addressed the meeting. He gave a brief sketch of the history of the power transmission section since its organization at St. Louis in 1910, and stated that the section has for its purpose the interesting of members connected with hydroelectric development and power transmission including electrical, mechanical and civil engineers, the power consumer, the operating man and the financier.

Mr. Doherty stated that over thirty million horsepower lie undeveloped along American streams and rivers and there is a need for developing a cheap form of high tension line construction to operate at the highest possible voltage. A solution of this problem will stimulate development and increase the demand for electrical energy in rural districts. It was the opinion of the chairman that the conservation policy of the present national administration is obstructive to the development of water powers and is seriously impeding progress.

Following Chairman Doherty's address Mr. A. W. Hahn,

of Denver, Col., presented the report of the committee on use of electricity for irrigation and agricultural purposes prepared by C. H. Williams of the Northern Colorado Power Co., of Denver. Mr. Williams was unable to attend and the report was abstracted by Mr. Hahn exhibiting afterward a large number of slides and interesting motion pictures showing benefits of irrigation in Northern Colorado and highly successful applications of motor drive in this class of service.

An interesting discussion followed in which many questions were asked on practices in irrigation and in developing irrigation pumping. This closed the work of the first power transmission session.

SECOND POWER TRANSMISSION SESSION.

The second session of the Power Transmission Section was called to order on Wednesday afternoon with Chairman Doherty presiding. A proposal was made to change the name of the section to Hydro-Electric and Transmission Section which proposal was put to vote and carried. A nominating committee was next appointed to report on nomination of officers for the ensuing year.

W. W. Freeman, Treasurer N. E. L. A.

A paper on the work of the United States government, relating to hydro-electric development was then presented by G. L. Parker, of Washington, D. C., the author Mr. John C. Hoyt, of Washington, being absent. This paper described briefly the extension work carried on by the U. S. Government in collecting and disseminating technical and engineering data. Government data is grouped under six topics, namely, water power, topography, geology, climate, social and industrial conditions, and experimental engineering data. Those who desire to keep in touch with the information of this character as it appears should subscribe for the monthly catalogue of U. S. public documents issued by the Superintendent of Documents at Washington, D. C., for which the subscription price is $1.10 per annum.

The report of the power transmission committee of the association was next in order and presented by D. B. Rushmore of Schenectady, N. Y., in the absence of the chairman, J. R. McKee, of New York City. It was the opinion of the committee that water power franchises ought to be made indeterminate. The committee criticises the present policy of the federal government in regard to conservation and declared that the existing restrictions on water power sites in the public domain are excessively burdensome and repressive. Mention was made of the Burton water power bills, now in the U. S. Senate and it was pointed out that neither of these bills are satisfactory.

At this meeting Hon. R. A. Ballinger of Seattle, formerly secretary of the interior, delivered a stirring address on the best means of developing natural resources. The former secretary of the interior declared that while Congress formerly controlled the government domain and the nation's policy was against federal landlordism, the government position has been reversed and the conservation policy has crippled the entire West and especially the Pacific Coast states and Alaska. He vigorously condemned administration of the federal domain to the destruction of private initiative and enterprise in the development of hydro-electric power enterprises.

At the close of this address J. A. Britton, of San Francisco, delivered a short talk expressing much the same sentiments as those voiced by Mr. Ballinger. He emphasized the fact that future development of the West can only be secured by removing the burdensome restrictions from the development of the public domain. Other remarks were added by Chairman Doherty and Messrs. Rushmore and Williams.

The report of the committee on power transmission progress was next presented by Secretary T. C. Martin. This report covers several topics including legislation, power sources, combined steam and hydro-electric plants, use of aluminum conductors, extra high voltage operation, and new systems. On account of the time consumed by the special features of this meeting the report of Secretary Martin and the following one by Stephen Q. Hayes, of Pittsburg were read in brief.

Mr. Stephen Q. Hayes presented a very interesting paper on switchboard practice for high tension power transmission treating not only the panel, pedestal, and bench types of switchboards, but also other features of general station and substation apparatus as well as some of the general features of design. The paper was mainly descriptive giving illustrations of the Tacoma Municipal Plant, Mount Hope Power Co., Olympic Power Co., Winnepeg Municipal Plant, and the Hydro-Electric Power Commission of Ontario.

The discussion of this paper was taken part in by a number present. The use of oil immersed transformers for outdoor substations was commented upon, stating that during hot weather transformer temperatures should be watched so as not to exceed a safe limit. The outdoor substations now in use were also commented upon, stating that considerable saving in cost was affected. This equipment however, it was pointed out, has not yet been fully developed.

THIRD POWER TRANSMISSION SESSION.

The final power transmission session was called to order Thursday afternoon by Chairman Doherty. The first work was the presentation of the report of the committee on receiving apparatus for transmission lines. This report was read by W. N. Ryerson in the absence of the chairman F. B. H. Paine of the Lockport & Ontario Power Co., Buffalo, N. Y. The report was brief on account of the fact that the committee was not appointed until February of the present year. For the purpose of increasing continuity of service, it was recommended not to cut out equipment until necessary or until the system disturbance is obviously more than momentary. No inverse time limit relays should be permitted. Machines of induction type are generally preferable and more stable than the synchronous types. The committee urged the development of apparatus for

keeping a continuous record of system disturbances and interruption. In the discussion following Mr. Ryerson moved that the committee be continued for another year and this motion was carried.

A paper on occurence of corona on high tension lines was next presented by E. S. Gehrkens, of Pittsfield, in the absence of of the author, G. Faccioli, of the General Electric Co. It was pointed out that while the occurence of this phenomina is not necessarily dangerous, one of the possible dangers is the production of ozone, and nitric acid which will probably attract the insulating and conducting materials. In the discussion one of the speakers described the effect of corona in high tension bus compartments where it was noted that the glaze had disappeared from the insulators under the tie-wires and also from the face of the bricks on the adjacent walls.

The report of the committee on protection from lightning and other static disturbances was read by H. B. Gear, in the absence of S. D. Sprong, of the Edison Electric Illuminating Co., of Brooklyn. This report was almost entirely devoted to a consideration of the best means of carrying on the work which falls within the committee's scope. The committee recommended that it be given an appropriation to carry on experimental investigation on representative systems. In the discussion following D. B. Rushmore, of Schenectady related the efforts to obtain satisfactory records of discharges through multigap lighting arresters. These efforts were not successful. It was discovered that the multigap lighting arrester would not stand up against an arcing ground without serious resistance, but the use of resistance in turn limited the discharge capacity. The more recent aluminium cell arresters have a much better discharge capacity and are the most satisfactory types for large systems.

The nominating committee submitted the following nominations for officers of this section for the coming year: Chairman, W. N. Ryerson, Duluth, Minn.; First Vice-President D. B. Rushmore, of Schenectady; Second Vice President P. M. Lincoln, of East Pittsburg; and Secretary Farley Osgood, of Newark, N. J.

Commercial Sessions.

Chairman H. J. Gille of the Commercial Section opened the first commercial session on Tuesday afternoon with his official address. He stated that commercial men in all branches of the industry are coming to recognize the benefits from co-operation and the importance of popularizing electrical service. He further mentioned the special booklet prepared by the section, stating that a good start has been made on the publication of a commercial digest containing data on electrical installations. Mr. Gille acknowledged indebtedness to P. S. Dodd, secretary of the section who has devoted his entire time to the work.

Following Mr. Gille's remarks, an address was made by W. W. Freeman o fthe Edison Electric Illuminating Co., of Brooklyn on, "Commercial Developments of the Electrical Industry." Serious consideration of commercial problems, said the speaker, was first given in an N. E. L. A. presidential address in 1902 when Henry L. Doherty then president, predicted that central station men would soon almost lose sight of technical matters except those relating to methods of increasing sales. This statement is now fairly well borne out by the electrical companies coming to realize the necessity of commercial work. He stated that present methods of generation, transmission, and distribution are practically good enough and that while progress will not be stopped in these directions, the greater growth of the industry depends entirely upon commercial work. Unlike other kinds of industry, the central station requires an enormous investment for its conduct and even the most prosperous company hardly turns over its capital once in five years. He showed load curves such if energy is taken at demands above 50 percent of the maximum demand provided for, the energy would cost the company at a rate much higher than it receives.

Following Mr. Freeman's address the report of the committee on membership to be presented by the Chairman, George Williams, was commented on by Secretary P. S. Dodd, of the Commercial Section on account of the absence of Mr. Williams. Mr. Dodd outlined the work of the section during the past year stating that 20,000 copies of a booklet on industrial lighting has been distributed to central station and manufacturing companies and that this circulation will be extended to reach all industrial plants of the country.

A comprehensive report from the committee on steam heating was next presented by A. D. Spencer in the absence of Chairman, S. M. Bushnell, of the Illinois Maintenance Co., of Chicago. Results were given obtained on commercial heating from over 100 companies. There are now something like 250 heating companies in the United States and the committee found that many of these are not earning any direct profit. The committee stating that a fair service charge appeared to be from 15 to 20 cents per square foot of radiation surface for heating season with an additional meter rate of about 30 cents per thousand pounds of steam condensed.

The discussion on the report was for the most part discouraging in regard to heating service as a desirable central station adjunct.

Next followed the report of the committee on electric refrigeration and electric ventilation of which committee John Meyer, of the Philadelphia Electric Co., was chairman. This report was read by C. A. Graves, of Brooklyn, N. Y., and consisted of four parts, one on refrigeration prepared by R. L. Lloyd, of Philadelphia, one on ice making by the committee, one on ventilation by Carl F. Scott, of New York, and one on laundries by John Richmond. The part on refrigeration shows load curves in typical refrigeration plants and gives much practical data. The section on ventilation takes up general features of the subject and comments upon installations in large modern hotels. The part on laundries points out the excessive steam requirements of this class of business and the difficulties for central stations in securing the business.

In the discussion on this report Mr. E. W. Lloyd stated that 600 tons of ice is being produced daily in Chicago by motor driven compressors. One plant produces a ton of ice on 60 Kw. hours in summer and 42 Kw. hours in winter and operates at a load factor of from 60 to 70 per cent. R. I. Tillman, of Baltimore, reported a good load factor of ice making plants, and stated that small ice machine business is increasing rapidly.

SECOND COMMERCIAL SESSION.

The second commercial session was held Tuesday evening at 8:30, President Gilchrist presiding. The meeting opened with a report of the committee on competitive illuminants by F. H. Golding of the Rockfrd Electric Co., of

Rockford, Ill., and was read by Ward Harrison of Cleveland, O., in the absence of Chairman Golding. This report presented valuable material relating to the replacement of gas lighting by electric lighting. Reports were gathered from central stations which shows that 91 installations of gas arcs, having a total of 1,057 mantles, were replaced by tungsten lamps with an average of 68 watts per mantle and in almost all cases the customer saved money and secured more light. The policy of prevailing upon customers to take more light for the same money has been successful in holding electric light customers against gas competition.

The discussion brought out the unanimous opinion that the comparative cost of gas and electric lighting is really of secondary concern compared with the superior service, dependability, safety and sanitary advantages of electricity.

The committee on industrial and commercial lighting of which E. H. Beil, of Youngstown Gas & Electric Co., Youngstown, O., is chairman, made no report this year except for the bulletin which has been issued on this subject and already mentioned.

The reports of the committees on electrical advertising and decorative street lighting and on residence business were postponed until the third session on Wednesday.

THIRD COMMERCIAL SESSION.

The third session of the commercial section was held Wednesday afternoon, Chairman H. J. Gille presiding. This session was opened by W. H. Hodge, of the H. M. Byllesby Co., Chicago, presenting the report of the committee on electrical advertising and decorative lighting, which report had been posponed at the second session. The other report postponed from the second session namely by the committee on residence business was presented at the fourth commercial session.

The report presented by Mr. Hodge gave valuable data on ornamental street lighting compiled under the direction of A. W. Bender of Cleveland for 50 cities in the United States and Canada. Out of 1874 cities in America the report showed that only 275 now have ornamental street lighting systems where the population is 5000 or over. The committee recommended that central stations install and own systems under municipal contract where possible. The appendix of the report contains much engineering and commercial data on ornamental street lighting. According to the statements of the report 80,000 electric signs are in use in the United States and Canada with an average of 100 lamps each. The discussion gave expressions of appreciation for the data contained, however criticised the lack of information on other than incandescent units for ornamental illumination.

Mr. L. R. Wallace of the Edison Electric Illuminating Co., of Boston, next presented the report of the committee on electric vehicles. The report comprised a study of electric vehicle practice in 67 central stations and showed that 49 of these owned and used 73 passenger and 381 commercial vehicles in central station work. In the territories of the other 18 central stations there are 648 electrical vehicles in use by the public. The total territory studied contains 11,044 passengers and 2,619 commercial electric vehicles including those in use by central stations. There are 421 public charging stations for these vehicles 67 of which are connected to one central station. The committee particularly emphasized the value of an electric vehicle charging load as off peak. The discussion brought out the fact that considerable education must be done in order to eradicate the prejudice in the minds of many against electrical commercial trucks on account of the dissatisfaction which the early models gave.

Electricity in Rural Districts was the subject next presented by J. G. Learned of the Northern Illinois Public Service Co., of Chicago. This report was abstracted by Mr. Learned and presented much data on the energy consumption and operation cost of electrical driven equipment. Description of numerous farm installations in Illinois were mentioned. The discussion brought out the methods of financing the extension and transmission distribution lines in rural districts. The number of methods by which the customer helped share the initial expense were also discussed.

H. H. SCOTT,
Second Vice President N. E. L. A.

Selling Current to Large Power Users of the Rocky Mountain and Pacific Coast States, was the subject of a report next presented by Joseph Lukes of the Tucker River General Electric Co., of Reno, Nevada. This report analyzed the returns from 27 companies selling energy to a total of 461 large customers none of whom consumed less than 25,000 Kw. hours per month. About a dozen industries were enumerated with load factors from 75 to 95 per cent. To these large customers, rates varied from 0.6 to 3 cents per Kw. hour, with little uniformity of practice on account of variation in location, load factor, demand and its relation to the peak, energy consumption and term of contract.

The discussion brought out the fact that more uniform methods of rates for charging for electrical energy are needed and definitions were asked on the line of demarkation between large and small power users arbitraily taken at 50 H. P. The subject of the extent to which an electrical company can act is electrical engineer and adviser for its customers was also taken up.

FOURTH COMMERCIAL SESSION.

The final commercial session was called to order Thursday morning by Chairman F. M. Tait, and a written discussion of the paper on increasing the power load by H. W. Cope, presented as prepared by E. D. Dreyfus of the Westinghouse Electric & Mfg. Co., of Pittsburg. The discussion

stated that the coal prices and cost fgures given in Mr. Cope's paper were exceptionally low and should not be given general circulation.

Following this discussion the report of the committee on residence business postponed from the evening session of Tuesday was given. This report was abstracted by J. F. Becker of the Union Electric Light and Power Co., of New York City. The report covers 92 pages and summerizes the methods and the progress made in securing residence business. The committee learned that most companies employ special solicitors for residence business, maintaining show rooms, present demonstrations and offer special wiring propositions. Data was presented on revenue derived from various classes of residences, on the load factors and on the cost of reading, testing and repairing meters. Also on rendering and collecting bills. The discussion of this paper took up particularly house wiring campaigns and central station relationship with local electrical contractors.

The next subject taken up was the report of the committee on cost of commercial department work of which E. L. Callahan, of the H. M. Byllesby Co., was chairman. The committee emphasized the desirability of maintaining complete records of commercial department costs. Sample forms were shown illustrating the proper accounting of the expenses. The report also contains a summary of commercial department costs in cities of various sizes. In the opinion of the committee two per cent of the gross revenue can be profitably spent in maintaining a commercial department. It also pointed out that 4 per cent is not too much when quick results are essential.

The report of the committee on contract order routine was presented by the chairman T. I. Jones of the Edison Electric Illuminating Co., of Brooklyn. This report took up the details in connection with handling contract order routine on the multiple basis. Particular attention was given to the importance of condensing clerical work and making the necessary records as brief as possible.

Mr. E. L. Callahan, of Chicago, next presented the collection of data compiled by his committee on the commercial index. This material represented a large amount of tabulated data, built up with the data book of the Byllesby organization as a center, to which had been added matter secured from other central stations and technical journal sources.

The next paper was presented by M. O. Troy, of the General Electric Co., of Schenectady, and discussed both the hygenic and industrial aspect of ozone, pointing out its practical relation to the central station.

Following the presentation of Mr. Troy's paper the nominating committee proposed the following names to serve as officers of the commercial section during the coming year. Chairman E. W. Lloyd of the Commonwealth Edison Co., of Chicago.; Vice Chairman T. I. Jones, of the Edison Electric Illuminating Co., of Brooklyn; Executive Committee, E. L. Callahan of the H. M. Byllesby Co., of Chicago; J. Robert Crouse of the National Electric Lamp Association of Cleveland; J. F. Becker, of the United Electric Power Co., of New York; F. B. Ray, Jr., F. H. Gale, M. C. Rypinski; George Williams, Philip S. Dodd, J. C. McQuiston, Stanley Walton, C. N. Littlefield, H. J. Gille, Douglas Burnett, and W. E. Robertson.

Accounting Sessions.

The first accounting session was called to order Tuesday afternoon by President Gilchrist. The first business was the report of the committee on "Uniform Accounting," by E. J. Bowers, of the Kansas City Electric Lighting Co., Kansas City, Mo. This report reviewed the work of the accounting committee and made recommendations for the future urging the general adoption of the association's system of accounting. The discussion on the report brought out the possibility for a uniform system in accounting for small as well as large companies, thus permitting comparison. It was also shown that in most cities franchises have no capitalization and that most commissions do not favor a capitalization of franchises.

A paper was next presented by W. H. Bogart, of the New York Edison Co., on the incandescent lamp accounting of his company. He said that incandescent lamps are received from manufacturers at one store room and delivered by electric wagons directly to customers or are transferred to the district store rooms. Traffic in lamps is prevented by a card record of each customer.

The exhaustive discussion following, took up the importance of preventing the traffic in lamps and the close checking necessary where an allowance is made on tungsten lamps and carbon lamps that have been used. It was generally agreed in the discussion, that it is inadvisable to include auxiliary charges on bills for electric energy. The cost of the delivery per lamp varies from 3½ to 8 cents. A liberal policy in regard to the removal of lamps tends toward large returns from the sale of energy as well as maintaining a higher candle power standard. It was learned that the Commonwealth Edison Co., of Chicago, handles their lamps through their operating department. The cost of delivery per lamp is 3½ cents. In Washington the cost of delivery is less than 3 cents per lamp on the system.

The next paper was entitled "Handling and Accounting of Scrap Materials," by Chas. E. Bowden of the Toronto Electric Light Co., Toronto, Canada. The author of the paper stated that few companies have enough scrap to make it economical to establish a special department to handle it and that this work should be done by the purchasing and stores bureau. Mr. Bowden has found from investigation that the low prices on scraps are due to the fact that all kinds of material had been thrown together and mixed so hopelessly that the cost of proper assortment to the bidder is so large that the material has to be sold for whatever price is offered. The discussions took up the importance of the disposing of scraps and crediting repair jobs with the salvage value of material.

A paper on general filing systems was next presented by R. H. Williams, of the Commonwealth Edison Co., of Chicago. The author urged that some person be held responsible for the filing and safe keeping of all records. Practical utility and economy should be the essentials of a central filing department and theoretical refinement should be avoided .

In the discussion a chart system for filing of correspondence without the use of a card index was displayed by E. M. Podeyn of Brooklyn and it was stated that this system had reduced the cost of handling such matter about 33 per cent. The Boston Edison Co. uses the same system. This closed the work of the first accounting session.

SECOND ACCOUNTING SESSION.

The second accounting session was called to order on Wednesday morning with W. W. Freeman presiding as chairman. The first business was the presentation of a

paper by Frank Heydecke, of the Public Service Electric Co., of Newark, N. J., on the subject of scientific management of an accounting department. He outlined the possibilities of explaining work to men and stated that the highest efficiency can be realized by scientific direction of the work to be done by the individual rather than by labor saving devices. The discussion brought out the qualifications of an auditor, and the benefits of periodical examinations as an aid to greater efficiency in clerical work.

The next subject, namely, Proper Accounting for the Sale of Electric Devices was presented by L. M. Wallace, of the Edison Electric Illuminating Co., of Boston, Mass. The paper discussed the electric appliance exchange as a part of the sales department and as operated independently of the sales department. The electric appliance exchange of the Edison Electric Illuminating Co., of Boston, is operated practically on a self supporting basis.

Central Station Motor Vehicle Costs and their Distribution to accounts Benefited, was the subject of a paper next presented by E. C. Scobell, of the Rochester Railway & Light Co., Rochester, N. Y. The author suggested two separate classifications, one for large companies containing 18 accounts and one for small companies containing nine accounts. Each vehicle should be given a serial number when purchased and known thereafter by it. Depreciation is taken care of by a charge of 20 per cent of the purchase price the first year, 15 per cent of the balance the second year and 10 per cent of the balance at the close of each year for the succeeding years. With this plan charges for the first two years will be heavy and repairs small. In later years the reverse.

During the discussion Mr. E. J. Bowers, of Kansas City pointed out that the cost of the operating electrical vehicles of his company taking all charges into account is about 25 cents per car mile, the sizes of vehicles ranging from 1,000 pounds to 3½ tons capacity. Mr. Douglas Burnett, of Baltimore gave the total cost of a 1000 pound electric wagon service at 17 cents per hour and 3½ ton trucks at 45 cents per car hour. S. B. Howard, of Detroit, Mich. offered to supply electrical vehicle service cost as determined by the General Motor Car Co., to all central station men desiring them.

THIRD ACCOUNTING SESSION.

The final accounting session was called to order Wednesday afternoon by F. M. Tait presiding. The paper on regulating electric light accounting was read by J. W. Lieb, Jr., of New York in the absence of the author H. M. Edwards. The paper stated that the division of capital charges into original, additions, betterments, renewals, and replacements was an unnecessary refinement. In commenting upon the system perscribed by the Wisconsin commission, Mr. Edwards said that the classification of the commission was evidently devised by practical men for everyday use of an intensely practical industry.

The paper on the progress made in the uses of the tabulating machine was read by Douglas Burnett in the absence of the author William Smith, Jr., of Baltimore. The paper answered many questions which had been received as a result of the previous paper and took up many details in the use of this device as a labor saving means. The discussion consisted principally of experiences of larger companies with tabulating machines.

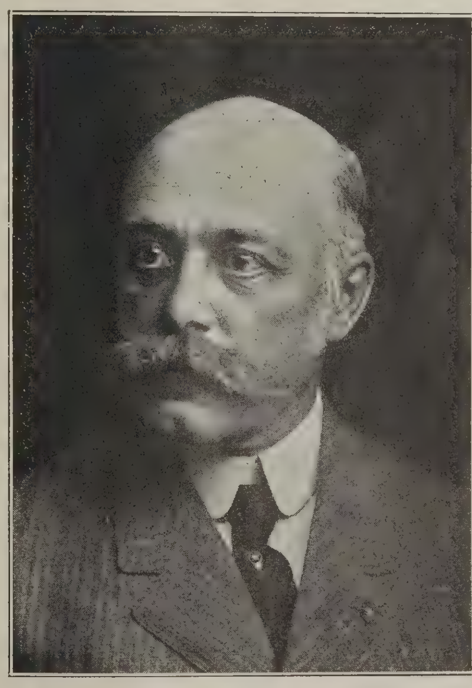
Public Policy Session.

This session was held Wednesday evening when the report of the Public Policy Committee was read by Samuel Insull. The full report embraces 80 pages of which 55 are devoted to appendices. The first report was presented at the 29th convention held in 1906. The present report reaffirms the conclusions of last year report which was almost entirely devoted to a consideration of the proper standards of compensation for employees of member companies. The subjects of industrial interest, regulation of utilities, education on municipal ownership, and welfare, hygene and minimum wages were topics touched upon.

Following the report of the public policy committee C. L. Eglan of the Philadelphia, Electric Co., presented the report of the medical committee on resuscitation from shocks. He reviewed the causes which led to the forming of a joint committee of the National Electric Light Association and the A. I. E. E., and the American Medical Association and demonstrated the method of resuscitation from electrical shock. After this demonstration a lecture was given by D. B. Rushmore, secretary of the power transmission session, on the electrification of the Panama Canal, its construction, and operation. This lecture was illustrated by latern slides.

Company Section Session.

The company section representatives held a meeting Thursday afternoon with W. W. Freeman presiding. Announcement was made that the award of the Doherty medal for best company section paper for 1912 went to C. N. Duffey of the Milwaukee Electric Railway & Light Co., Milwaukee, Wis. The next business was the presentation of a paper on educating central station employees by H. E. Grant, of San Francisco. This paper was scheduled for the second general session of Wednesday morning, but was postponed. Mr. Grant pointed out that the best results cannot be obtained from perfection of materials, methods and machinery, if the men who guide the mechanism are



T. C. Martin, Executive Secretary for Past Two Years.

untrained. Detailed information was given concerning the course of the New York Edison Co., which course takes up four principal lines. The elements of central station business getting, hygene, health and recreation; elements of Psychology; basic principles of salesmanship and relation to business getting; scope, policy and organization of the New York Edison Co.

Following this paper Secretary T. C. Martin presented a plan for a lecture bureau to furnish valuable lecture features for company sections. The bureau would preferably be under the control of the secretary of the association and Mr. Martin cited the names of a number of leaders in the industry who have offered their own time and services for the purpose of the lecture bureau mentioned. Among these are Mr. Edison, Prof. Elihu Thompson, and H. L. Doherty.

Special Irrigation Session.

On account of the interest shown in the subject of irrigation during the first power transmission session, a special informal discussion was held Thursday morning on the subject. The discussion which took place brought out the various contracts used and touched upon the conditions of service. The most popular contract is based upon a flat rate of $50.00 per Hp. year. The average size of motor is 7½ Hp. and the maximum 75 Hp. The cost of line construction is about $650 per mile and the pumping plants have an efficiency of about 50 per cent.

Entertainment Features.

The entertainment features during the three days of the convention were arranged principally for the ladies attending. However, practically all of the golf clubs in the vicinity extended the privileges of their courses to the men delegates and guests. The stations of the Puget Sound Traction, Light & Water Co., were also opened to any one wearing a badge.

The main entertainment program began with a ball game at the University of Washington campus on Monday afternoon followed by the reception to President and Mrs. Gilchrist in the evening. On Monday afternoon automobiles called at the hotels and took the ladies on a tour of the city. On Wednesday afternoon a short boat ride trip on Puget Sound gave the ladies an opportunity to view the city from the water and to see the town with its setting of snow capped mountains. After this trip a musicale tea was held on the roof garden of the Hotel Washington. On Thursday afternoon a ladies golf "putting" contest was held at the Seattle Golf & Country Club, in which the winner received a silver cup. In the evening the Sons of Jove held an initiation and joviation at which the Seattle and Tacoma Jovians combined, taking in 88 members and providing a special banquet when addresses were made by prominent Jovians. On Friday the delegates and ladies were guests of the Puget Sound Traction Light & Power Co. for a trip to Suoqualmie Falls and the White River developments. A special train was provided and lunch served en route.

EXHIBITORS AT CONVENTION.

American District Steam Company, North Tonowanda, N. Y. Special steam heating fittings. E. L. Barnes.

Benjamin Electric Manufacturing Company, Chicago, Ill. Lighting specialties. W. D. Steele.

Century Electric Company, St. Louis, Mo. Single-phase motors. R. J. Russell, H. H. Thedinga, S. B. Smith, R. J. Davis.

Commercial Section, N. E. L. A.

Copeman Electric Stove Company, Flint, Mich. Automatic cook stoves. L. G. Copeman, K. W. Dawson.

Dalton Adding Machine Company, Poplar Bluff, Mo. Adding machines. V. O. Boone, J. G. Meeko, E. W. Harris.

Dearborn Drug and Chemical Works, Chicago, Ill. Literature on boiler feed water, lubricating oils and greases. E. C. Brown, J. W. Harkins, J. B. Lincoln.

Electric Storage Battery Company, Philadelphia, Pa. Storage batteries. G. H. Atkin, J. Gay, G. R. Murphy, W. G. Bardens, H. S. March, J. W. Conley.

Electrical Review and Western Electrician, Chicago, Ill. A. A. Gray, F. R. Schalck.

Electrical World, New York. H. M. Wilson, A. E. Clifford, C. L. Williams, G. W. Elliott, H. T. Matthew, W. E. Keily, F. F. Fowle, O. H. Caldwell, H. S. Knowlton, W. H. Onken, Jr.

Eureka Vacuum Cleaner Company, Detroit, Mich. Vacuum cleaners. F. Wardell, A. L. Generaux.

Federal Sign System (Electric), Chicago, Ill. Electric signs. J H. Goehst, J. M. Gilchrist.

Fort Wayne Electric Works of General Electric Company, Fort Wayne, Ind. Meters, electrical apparatus and ice machines. F. S. Hunting, G. I. Kinney, W. R. Hendrey, H. L. Eicher.

Franklin Electric Manufacturing Company. Incandescent lamps. P. W. Huston.

General Electric Company, Schenectady, N. Y. Electrical machinery apparatus and instruments. Dr. T. Addison, J. A. Cranston, T. E. Bibbins, R. T. Cash, T. Beran, R. E. Moore, H. L. Monroe, G. D. Rosenthal, C. B. Burleigh, F. G. Vaughen, N. R. Birge, E. E. Gilbert, A. D. Page, F. H. Gale, M. G. Troy.

G. & W. Electric Specialty Company, Chicago, Ill. Pot heads and junction boxes. G. P. Edmonds.

Hubbard & Company, Pittsburgh, Pa. Pole line hardware. R. N. Dickinson, A. E. Boyles.

Hughes Electric Heating Company, Chicago, Ill. Electric stoves. G. A. Hughes, C. H. Weaver, B. R. Stare, Miss Reddington.

Hurley Machine Company, Chicago, Ill. Washing machines. N. Hurley.

H. W. Johns-Manville Company, Chicago, Ill. High and low tension protective devices; meter protective apparatus and refrigeration. J. W. Perry, J. C. C. Morris, F. S. Mills, S. P. Russell, R. C. Cole, W. E. Wright, G. G. Gunderson, F. W. Doty, B. Hatton, G. A. Saylor, V. A. Wellman, H. G. Peterson, D. A. Boylan, I. T. DeSilva, F. W. Loomis.

Meter Exhibit, N. E. L. A. Meters and meter accessories.

Metropolitan Engineering Company, Brooklyn, N. Y. Protective devices. T. E. Murray, P. E. Brown.

Minerallac Electric Company, Chicago, Ill. Insulating material and instruments. H. S. Sines, C. N. Arnold.

National Electric Lamp Association, Cleveland, Ohio. Incandescent electric lamps. J. R. Crouse, H. A. Tremaine, S. E. Doane, W. M. Skiff, W. Harrison, L. S. Twomey, R. Beman, R. E. Campbell, J. A. Vendergrift, H. Eisenmenger, E. H. Haughton.

Northwest Electric Light and Power Association, Portland, Ore. Geographical Section, N. E. L. A.

Otis Elevator Company, Yonkers, N. Y. Literature on elevators. R. W. Charles, R. J. Huntington, J. C. Bebb, R. A. Parks.

Pacific Electric Heating Company, Ontario, Cal. Electric heating appliances. F. Booth, H. T. Van Riper, J. N. Bowden, H. T. McCrea.

Philadelphia Electrical Manufacturing Company, Philadelphia, Pa. Lighting specialties. C. L. Bundy.

Portland Railway, Light & Power Company, Portland, Ore. Roses. H. L. Gray, C. C. Crawford, Miss Hawley.

Puget Sound Traction, Light & Power Company, Seattle, Wash.

Secretary's Headquarters, N. E. L. A.

Simplex Electric Heating Company, Cambridge, Mass. Electric heating appliances. G. Young, F. G. Larkin, F. H. Smith, J. I. Ayer.

Transportation Headquarters, N. E. L. A.

Wagner Electric Manufacturing Company, St. Louis, Mo. Single-phase motors and instruments. F. N. Jewett, J. Mustard, A. T. Myers, T. S. Clark, F. R. Bates, R. D. Lillibridge.

Waverley Company, Indianapolis, Ind. Electric automobiles. F. T. Bird.

Western Electric Company, Chicago, Ill. Fans, domestic appliances and telephones. F. B. Gleason, P. J. Aaron, Carl Bush, L. Brown, M. H. Nichols, F. Parrish, A. L. Phillips.

Westinghouse Companies, Pittsburgh, Pa. Electrical machinery apparatus and instruments. G. E. Tripp, L. A. Osborne, S. L. Nicholson, W. W. Briggs, C. S. Cook, G. B. Griffin, J. C. McQuiston, A. A. Brown, W. S. Rugg, J. J. Gibson, W. E. Brett, T. P. Gaylord, C. E. Heise, K. E. Van Kuran, A. Tobias.

Weston Electrical Instrument Company, Newark, N. J. Instruments. F. E. Smith, A. Honeychurch.

Instrument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively to* Southern Electrician).
BY E. P. PECK, ASST. ELECTRICAL ENGINEER, GEORGIA RAILWAY AND POWER COMPANY.

Section 7.—A Discussion on Transformer Tests.

When an acceptance test is made on a transformer, or when transformers are tested for comparative results, the test should cover heating on full load and stated overloads, overvoltage test for insulation strength, and efficiency tests. When transformers are put in service polarity tests and oil insulation tests are often necessary.

HEAT TEST.

For a heat run the transformer may be connected to its regular load, if such load may be adjusted to and held constant at the required value. If this is not convenient a water rheostat or other load may be used. On heat tests the voltage and frequency should agree with the rated voltage and frequency of the transformer.

If two or more of the transformers are to be tested they may be loaded by an opposition method. Connections for one opposition test are shown in Fig. 2. Be sure that the primaries are connected so that they are bucking. For large transformers the opposition method is much preferred because the energy wasted is only the loss in the transformers plus the regulating rheostat loss. The core loss is supplied from the line at normal voltage and the copper loss is supplied from the third transformer, or some other source of current, at low voltage. It is generally possible to arrange the connections to the extra transformer which supplies the copper loss so that its voltage is not very greatly in excess of the voltage necessary to furnish full load current. The voltage required from this transformer is approximately twice the impedence voltage of the tested transformers, which is from one per cent to seven per cent of the normal voltage of the transformer.

The transformer connections may be reversed if desired so that the core loss is supplied at high voltage through the primaries and the copper loss current supplied to the secondaries. the load should be kept at a constant value until the transformers reach a stationary temperature, which will take several hours.

Temperatures may be taken from themometers placed on the core and on the coils—several themometers being used in each transformer. Room temperature should be taken at two places at least. The temperature rise is the difference between room temperature and transformer temperature at the end of the run. Temperature readings should be taken at regular intervals so that the progress of the heating may be known. The rise in temperature may also be taken by the resistance method in which the resistance of the coils is measured with the transformer at room temperature and again at the end of the heat run. The reader is referred to an Electrical Engineers hand book for details of this test.

If the room temperature is not 25 degrees C. the temperature rise should be corrected to what it would be if the room temperature was 25 degrees C. This correction is given in the Standardization Rules of the A. I. E. E. as ½ per cent for 1 degree C. That is, if the room temperature is 35 degrees C. the temperature rise must be decreased 5 per cent and if the room temperature is 15 degrees C. the temperature rise must be increased 5 per cent.

INSULATION TESTS.

The "Standardization Rules" recommend that transformers having primary pressures of from 550 to 5,000 volts, the secondaries of which are directly connected to consumption circuits, should have a testing voltage of 10,000 volts, to be applied between the primary and secondary windings, and also between the primary winding and core. If the primary voltage is over 5,000 volts the test should be at double voltage. Any transformer for commercial service should stand 1,000 volts from secondary to core.

A high voltage testing transformer is most convenient for this test but if it is not available, the testing voltage may be obtained from the necessary number of stock transformers connected with the secondaries in parallel and the primaries in series. If 2,200 volt transformers are used it is better not to connect more than six in series for this test on account of the strain produced between the primary and secondary coils of the transformers.

For the test of the primary coil, connect the primary leads together; also connect the secondary leads together and to the core and case. Voltage should be applied from secondary to primary for one minute.

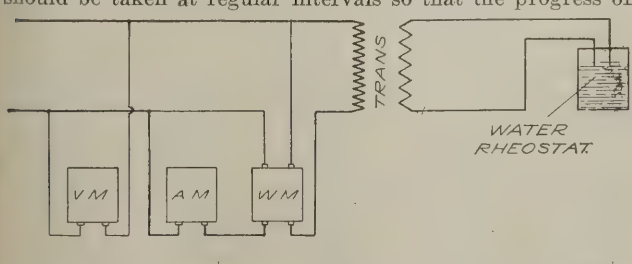


FIG. 1

Fig. 1. Connections for Transformer Load Test Using Water Rheostat for Load.

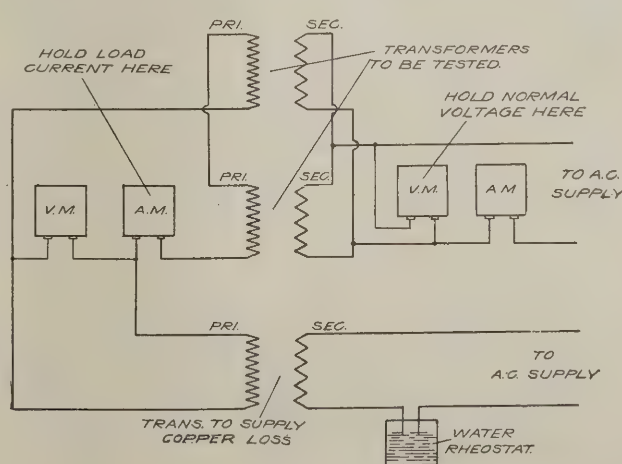


FIG. 2.

Fig. 2. Connections for Transformer Load Test by Opposition Method.

To test the secondary coil, connect the secondary leads together; also connect the primary leads together and to the case. Apply voltage from secondary to core and case for one minute.

When making high voltage tests it is well to put a spark gap, set for the desired voltage, in parallel with the apparatus to be tested, in order to limit the voltage to the desired value. The following table of sparking distances between bright needle points is given in the Standardization Rules. It is recommended that no extraneous body be within a distance of twice the length of the gap and that a non-inductive resistance of about one-half ohm per volt be inserted in series with each terminal. An ammeter should be connected in series with the low voltage side of the testing transformer. The ammeter will read due to the charging current of the tested transformer, and will give greatly increased reading if transformer breaks down.

TABLE OF SPARKING DISTANCES.

Kilovolts Sq. Root of Mean Square	Distance Inches	Distance Cms	Kilovolts Sq. Root of Mean Square	Distance Inches	Distance Cms
5	0.225	0.57	140	13.95	35.4
10	0.47	1.19	140	15.0	38.1
15	0.725	1.84	160	16.05	40.7
20	1.0	2.54	170	17.10	43.4
25	1.3	3.3	180	18.15	46.1
30	1.625	4.1	190	19.20	48.8
35	2.0	5.1	200	20.25	51.4
40	2.45	6.2	210	21.30	54.1
45	2.95	7.5	220	22.35	56.8
50	3.55	9.0	230	23.40	59.4
60	4.65	11.8	240	24.45	62.1
70	5.85	14.9	250	25.50	64.7
80	7.1	18.0	260	26.50	67.3
90	8.35	21.2	270	27.50	69.8
100	9.6	24.4	280	28.50	72.4
110	10.75	27.3	290	29.50	74.9
120	11.85	30.1	300	30.50	77.4
130	12.90	32.8			

EFFICIENCY TESTS.

To make an efficiency test, the core losses and copper loses are measured and the efficiency calculated. The rating of a transformer is its output in watts or kilowatts. The efficiency calculated from its losses is obtained as follows: Efficiency = K. W. output ÷ output + core loss + copper loss.

The core loss may be measured from either the primary or secondary side but when possible to do so it is better to excite from the low tension side as the current is greater and precautions need not be taken for high voltage on the instruments. For this test connect the transformers and meters according to Fig. 3. The wattmeter reads the total iron loss and the ammeter gives the exciting current. The product of volts and amperes is the apparent watts, and the power factor is obtained by dividing the watts by the volt amperes.

The voltage and frequency should correspond closely with the rated values of the transformer as a variation of either will cause the core loss to be different from its correct value.

CORRECTION TABLES.

Variation of Core Loss With Voltage.

Volts (% nor.)	90.	95.	96.	97.	98.	99.	100.
Core loss	83.7	91.7	93.3	95.	96.7	98.4	100.
Volts (% nor.)	101.	102.	103.	104.	105.	110.	
Core loss	101.6	103.3	105.	106.6	108.3	116.6	

Variation of Core Loss With Frequency

Cycles	55.	56.	57.	58.	59.	60.
Loss	103.9	103.12	102.3	101.6	100.8	100.
Cycles	61.	62.	63.	64.	65.	
Loss	99.3	98.5	97.8	97.	96.4	

The above table was taken from "Direct and Alternating Current Testing," by Frederick Bedell.

A wave form differing from a sine wave will change the core loss—a flat top wave causing a greater loss and a peaked wave a lesser loss. The wave form cannot be controlled on a circuit so this error if present cannot be corrected for, but it may amount to several per cent of the iron loss.

The copper loss may be measured with a wattmeter using connections as shown in Fig. 4, or the resistance of the primary and secondary windings may be measured by the drop in potential method and the losses calculated. When measuring the copper loss with a wattmeter on the alternating current one side of the transformer is short circuited—care being taken to make the short of as low resistance as possible. The same meters may be used on this test as on the core loss test.

With connections as shown, the voltage on the transformer should be raised until the ammeter indicated full load current. The wattmeter reads the total copper loss plus a neglible core loss. The voltage necessary to furnish full load current is the impedance voltage of the transformer. To obtain the copper loss by resistance measurement, send direct current, not greater than 25 per cent load, through the primary and secondary coils separately, and measure the current and drop in voltage across each winding. The resistance in ohms equals volts drop divided

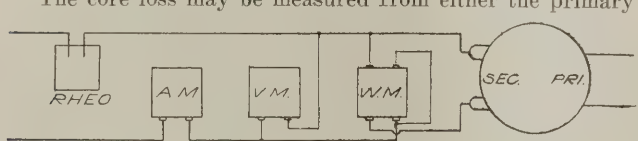


FIG.3.

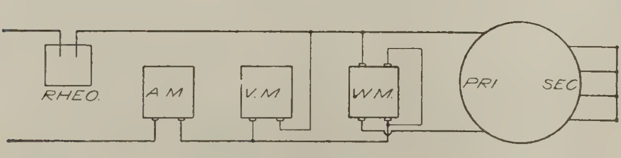


FIG 4

Fig. 3. Connections for Core Loss Test.
Fig. 4. Connections for Copper Loss Test.

TABLE OF TRANSFORMER EFFICIENCIES.

Size K. W.	Per Cent Efficiency at Full load.	¾ load	½ load	¼ load
1	95.8	95.7	95.1	92.1
5	97.3	97.5	97.3	96.1
10	97.8	97.9	97.7	96.6
25	98.2	98.3	98.2	97.4
50	98.4	98.6	98.5	97.8
100	98.6	98.7	98.5	97.8
200	98.3	98.3	98.	96.7
500	98.5	98.4	98.	96.6
3000	99.	99.	98.8	98.1

by amperes for each winding. The loss is equal to full load current squared times the resistance (Watts loss = I^2R) for each coil. Unless otherwise specified the copper loss measurement should be made at or corrected to 25 C.

Temperature readings should be taken on the transformer at the time copper loss measurements are made. Copper increases in resistance .4 per cent per degree C. rise in temperature and the copper loss will increase at the same ratio. Copper loss measurements if made at any where near full current should be made quickly to prevent undue increase in temperature.

When measuring the resistance by the drop in potential method, the voltmeter which is connected across the transformer windings should be removed before the current circuit is opened. If this is not done the voltage kick produced on opening the circuit will damage the voltmeter. In all of these tests the meters should be separated from each other at least 18 inches and preferably three feet. They should also be kept several feet from the leads carrying heavy current and from electrical apparatus.

It is important in these tests, as in others, that the instruments be properly proportioned to the values measured. From the table of transformer efficiencies the total losses in the transformer may be estimated. The relative values of core loss and copper loss will vary in transformers made by different manufacturers and in transformers for different classes of service, but for the purpose of selecting meter sizes to measure these losses they may be assumed to be equal.

The wattmeters then should be of such capacity that one half of the total loss in the transformers will give over half scale deflection.

REGULATION TEST AND RATIO TEST.

The regulation of a transformer is the ratio of the rise in secondary voltage, from full load to no load, to the secondary voltage at full load, with a constant voltage on the primary. The regulation may be measured or calculated, but as the calculations are somewhat tedious they will not be taken up. For measuring the regulation connect the transformer as for service. Measure the primary voltage on one voltmeter and the secondary voltage at no load and at full load with another voltmeter. The voltmeters should be carefully standardized as a small error in measurement will make a large error in the ratio determination. The primary voltage is measured through a standard voltage transformer. These readings will give the ratio directly, and the per cent regulation $= 100 \times$ (No load volts — Full load volts) $\div$ Full load volts.

POLARITY TESTS.

Transformers which are to be connected in multiple or in banks in delta or star must be connected with reference to their polarities. If all of the transformers are of the same make it is safe to assume that their polarities are the same. It sometimes happens however that a repaired transformer will have its polarity reversed and transformers from different makers are liable to be different in polarity. A simple polarity test is made by connecting the primary and secondary in series and exciting the primary at normal voltage. Take voltage readings across the primary and across the primary and secondary in series.

Connections are shown in Fig. 5 for this test. If the voltage is either higher or lower across both coils in series, than on the primary only on all transformers, they are all of the same polarity and may be connected as desired without reversing the transformer leads.

Another way to compare polarities is to assume one of them correct and to connect each transformer to it—putting the primaries in parallel with its primary, and connecting the two secondaries in parallel through a fuse. The fuse should be large enough to carry a circulating current which may exist, but small enough to blow without damage to the transformers if the connection is wrong.

DRYING OUT.

The different transformer manufacturers recommend different procedures in drying out high voltage transformers, but they agree that any transformer which shows evidence of moisture, and all extra high voltage transformers, should be thoroughly dried before being put in service. Transformer drying is a rather extensive subject and only general methods can be given here. It is recommended that instructions be obtained from the manufacturers when very important work of this kind is to be done.

One method of drying transformers is to heat them electricially. The transformer may be dried either in its case—without oil—or on the floor. The low voltage coil is short circuited and alternating current is applied to the high voltage coil. A large per cent of the transformers in service will require from 1/5 to 1/2 of full load current to maintain the necessary temperature, although some of the latest transformers will require full load current. The voltage required on the high tension winding will vary from 20 per cent of the impedance voltage to full impedence voltage.

For controlling the current a rheostat is placed in series with the high tension winding. The temperature, measured by several themometers placed well down between the coils, should not exceed 90 degrees C.

The transformers may be dried in a large box by heated air. The box should be provided with vents at top and bottom for air circulation. One manufacturer makes a

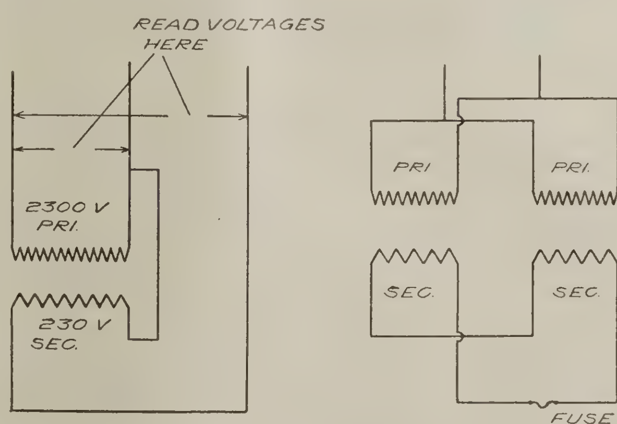


FIG.5

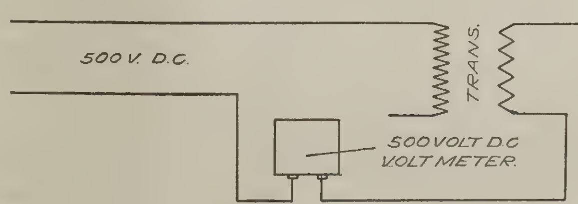


FIG. 6.

Fig. 5. Connections for Polarity Tests.
Fig. 6. Connections for Insulation Resistance Test.

hot air blower outfit for this work. If this or similar apparatus is not at hand, a resistance may be placed below the transformer and heat obtained from it. The resistance is worked at a high temperature and oil should not be allowed to drop on it as there is danger of setting the oil on fire. If desired a steam coil or other source of heat may replace the electrically heated resistance.

A combination of the first and second methods may be used, in which case the circulating currents in the windings are kept at a lower value than in the first method alone. No part of the transformer should exceed 90 degrees C.

If there is any way of obtaining a vaccuum, an excellent way to extract the moisture is to seal the transformer in its case and heat as in the first method and maintain as high a vacuum as possible in the case. The time necessary to completely dry the transformer will vary from 24 hours to a week or more. The time required depends on the size and construction of the transformer and the amount of moisture present. An indication of the progress of drying may be obtained by resistance measurements. The insulation resistance of a transformer does not in any manner tell the resistance to break down, but insulation resistance tests made as the drying progress gives a fair indication of the progress made in drying.

The test should be made with 500 volts and a 500 volt voltmeter. Connections are made as shown in Fig. 6. The insulation resistance is $R = r(V/v - 1)$, in which R equals insulation resistance, r equals voltmeter resistance, V equals line voltage, v equals test voltage. As the transformer is heated the resistance will decrease very greatly and after reaching a minimum it will rise as the drying progresses until it reaches a constant value, provided the temperature is kept constant.

OIL INSULATION TEST.

The oil used in transformers must be very free from moisture and impurities. The curve, Fig. 7, given by C. E. Skinner in the Electric Journal, shows that an extremely small amount of water will greatly reduce the insulation strength of the oil.

Oil will often collect water when it is in a receptacle which is apparently absolutely water proof and no oil should be poured from the tanks into transformers until it has been tested. The oil should be allowed to settle for 24 hours and a sample drawn off by means of a glass tube which is open, but which is reduced in size, at both ends. The tube is inserted to the bottom of the barrel, the top is closed and the tube withdrawn. Any large amount of moisture may be seen as drops in the oil. The sample drawn off should be tested for insulation strength with high voltage.

The General Electric Company states that, "Oil for transformers of 40,000 volts and over should be dried before using, if it punctures below 35,000 volts. For transformers having voltages less than 40,000 volts, the oil must be dried if it punctures below 25,000 volts." The above tests are for a gap of .2 inch between bright needle points. The voltage should be raised gradually until the breakdown is continuous. The breakdown voltage may be measured by an air spark gap in the high potential side or by a voltmeter in the low potential side of the testing transformer.

A Review of Coal Strike in England.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY CECIL TOONE, AN ENGLISH CONSULTING ENGINEER.

A Discussion of Effects of Strike on Central Stations and Other Industries.

The most serious strike which has occurred in this country is nominally over but it is hard to surmise what the real end will be. For over five weeks, industry was paralysed by that most impossible demand, a minimum wage irrespective of minimum output. Most of the colliers already earned more than the minimum demanded though they rarely worked 6 days per week, often only 3 or 4. Though the unprecedented and unreasonable demand has only been granted in part, the precedent established by legislative admission of even the bare principle of the minimum wage is of the gravest possible significance and has already led to similar disturbance, though on a much smaller scale, in other trades.

Syndicalism, differing essentially from Socialism in that it recommends joint ownership by the workers, instead of by the State and regards every class except the actual manual workers as parasitic, has raised its head for the first time in this country and its social danger cannot be exaggerated. The recent strike was undoubtedly engineered as the preliminary to a far more sweeping movement and we have every reason to congratulate ourselves that its full aim has been frustrated. By the rigid application of our Conspiracy Law, the further activity of professional agitators must be strictly curtailed.

In the conferences immediately following the commencement of the strike, 65 per cent of the colliery owners agreed to the principle of a minimum wage which the Government then proceeded to enforce by a special Bill. The men demanded the enforcement of the minima they had chosen and though they never gained this point, the Government took no steps during the following, (useless), weeks of the strike, to determine equitable rates, to be binding on men and owners alike, under penal law and liability to attachment of Union funds, but established District Conciliation Boards and the impossible principle of compulsory arbitration. The latter is a contradiction of terms and its futility in practice has already been instanced in Australia and New Zealand. Experience has shown that no contract is honored by the men unless it suits their convenience and, whereas employers are easily subjected to legal compulsion, no responsibility can practicallly be attached to a body of workers breaking their agreements. So much for the general features of the strike. To deal fully with its calamitous effects would need far more space than is here available hence it is proposed to quote only a few general data and deal more fully with the effects of the strike on electricity supply stations.

PREPARATIONS AND ECONOMIES.

Among our railways, the Great Eastern was the only line which made adequate preparation for the strike and whereas many routes were practically suspended for several

weeks, this line maintained full service throughout. The fact that, in the event of the strike not maturing, excess prices paid for coal during the panic of February would be dead loss, no doubt prevented many industrial concerns from laying in a suitable stock but in other cases such as cotton mills, no storage space was available sufficient to hold the huge amounts of fuel required for several weeks' working. Many central stations were in this position so that, though some concerns were able to store sufficient fuel to last till the middle of June, others could only lay in a fortnight's supply. Few stations can store more than 1000-2000 tons of coal and, had the strike lasted another week there would surely have been a number of cessations of supply. Annual coal contracts were often on such a basis that emergency stock could only be procured at increased prices. Despite the threat that dockers would not handle foreign coal, there is no doubt that considerable quantities were imported by various channels during the disturbance.

One of the first economies in central station supply, when it was seen that a long strike was inevitable, was to restrict street lighting, both in hours and in number of lamps. Ultimately, however, in the interests of public peace and safety, domestic and all other supply would have been cut off to keep a sufficiency of street lamps alight for as long as possible. Electric train and tramway services were at once curtailed and the B. O. T. regulation against standing in L. C. C. tram cars was suspended. On electric suburban railway standing, though illegal, always occurs during rush hours and overcrowding became especially acute during the strike.

Numbers of gas and electric supply companies circularised their consumers to economise wherever possible and the Yorkshire Power Co., reminded numbers of its power consumers that their tariff agreement provided for an increase or decrease of 3c per kw. hr. for every 12c per ton paid above or below $2.00 at the station.

SOME EFFECTS OF THE STRIKE.

Soon after the commencement of the strike, much interest was aroused by discussions as to what class of electrical consumer should be first disconnected in case of necessity. The manufacturers' section of the London Chamber of Commerce passed a resolution that stations should continue supply as long as possible to factories and, in preference, to those employing the greatest number of workers. Owing to the restricted service on steam railways, tramways serving towns and their outskirts experienced a great increase in traffic, thus the Burnley trams carried 20,000 passengers above the normal number in the second week of March.

During the third week of the dispute, industrial paralysis became really acute and from this time to the end of the strike, great misery and privation arose in many parts of the Midlands and especially in the Potteries, always among that class to which the miners belong. Shipping freight rates were raised to cover the enormous increase in coal prices. The Westinghouse Co., suspended the remaining 6,500 of their 7,500 employees owing to the shortage of raw material and the National Gas Engine Co., suspended its 2,000 hands. Much iron trade was reported as going to the Continent and there was already serious prospect of blast furnaces having to be blown out if the coal shortage continued.

During the fourth week of the struggle, the Liverpool tramways reduced their service 20 per cent; the Halifax Gas Dept. halved its coal stock with the Electricity Dept., both expected to have to shut down by the end of the first week in April, and the Sunderland station actually circularised power consumers for information as to sources of coal supply and asked them whether they would prefer disconnection or a higher tariff. By friendly discussion with the Electricity Dept., in West Ham, (where coal had been steadily purchased at every opportunity after the strike became certain), manufacturers agreed to a temporary increase of 0.25 per unit in the power tariff—a generous and reasonable distribution of the burden. In Bradford, the decrease in the demand due to works closing, was more or less balanced by the greater tramway load and the great increase in the number of electric radiators used for heating purposes during a short spell of cold weather. The mild spring greatly minimised the after effects of the strike.

The Miners Associations paid out over $6,250,000 in strike wages to a membership of 653,200 and in several parts of the country, the Union funds have been completely exhausted. The nominal balance in hand for the whole country is roughly $3,000,000. In other industries, workers shared the loss of time wherever possible, in order to reduce the drain on their Union funds. During the fourth week of the strike, the total payments from all Unions amounted to $1,915,000. The beginning of the end arrived with the return to work against the command of their leaders, of miners in Derbyshire, Lancashire and Scotland. By this time, the workers directly and indirectly affected by the strike had lost 50 million working days and 60 million dollars in wages, which amount was very imperfectly covered by strike pay and other benefits and which was, in any case, still a complete loss to the working classes.

During the ten years 1901-1910, 4637 disputes involved 2,200,000 workers and lost 41,600,000 working days whereas the present single dispute has, in five weeks, lost two and a half million workers 50,000,000 days of employment! The rapid increase in the number and extent of labor troubles, disclosed by recent statistics, is largely due to the Socialistic trend of legislation and to the dangerous effects of modern "education" as distorted and misapplied in the lower ranks of Society.

The central station crisis became very acute during the first week of April, but no serious measures were necessary. Gas supply had to be cut off in Birmingham between the hours of 1 p. m. and 7 p. m. and in another week it would have been necessary to cut off supply from 4 a. m. to 8 p. m. Several cotton firms in Nelson closed down because coal bought at fabulous prices was of such quality that the looms could not be kept running. Coal which would hardly bring $2.00 per ton at ordinary times in the cotton district sold briskly, (often more briskly than it would burn), at $9,00 per ton. Fortunately the important mills only lost a few working days and there is now every prospect of a cotton boom . "Pick-up" coal was everywhere at a premium. One large colliery paid $6,000 for coal picked up from its own waste tips by its own men, and, at another colliery, contractor despatched 700 tons thus precured. Shallow surface coal deposits were eagerly worked and several fatalities occurred owing to the careless methods employed.

And then, after seeking to hold up the whole nation for five weeks, the national strike disintegrated and utterly col-

lapsed. Between forty and fifty thousand men resumed work before the official termination of the dispute and in defiance of their leaders. As a result of a ballot, (carried out under disgraceful conditions of publicity and coercion) a 10 per cent majority of miners was obtained against resumption but their delegates at the National Conference so cast their votes that a 4:1 majority was obtained among the leaders for resumption. The edict went forth and the men resumed work but sullenly and under a realisation of the extent to which they had been misled. For a loss of \$40,000,000 in their own wages and a total loss in wages and output of about \$250,000,000 and the endless privation which their obstinacy involved, they gained nothing which the Government did not guarantee during the first week of the strike. We may be devoutly thankful that the threatened International Strike, affecting one-sixth of the human race, did not mature but, as things are, the future is gloomy enough. The Minimum Wage Act, so far from giving permanent peace, has already evoked great discontent. The Bill received Royal Assent on March 29th. but today, (May 20th), only one of the twenty-two districts formed has agreed upon the wages to be paid and only in six cases could the masters and men agree upon the independent chairman to be elected. In one case, the decision of the chairman was unacceptable to the men and last week there were threats of a resumed strike in the area in question, (south Wales). So much for the value of compulsory arbitration and the pledge of a body of workers.

PROSPECTS.

Apart from the insidious precedent it affords, the "minimum wage" will cause a permanent increase of \$0.25 to \$0.50 per ton in the market price of coal and will thereby enhance every cost of production and increase the liability to innumerable wage disputes. Under a minimum wage schedule, it is obvious that young lads and old men, incapable of earning the minimum fixed, will be thrown out of employment and a number of collieries, working deep and and narrow seams—in fact the very pits to which the minima were chiefly intended to apply—will probably be closed. Already some such pits have been abandoned.

Nor does it follow that conditions will be at all improved for those men remaining in work for the recent prolonged cessation of coal supply led to such economy of utilisation as could have been attained by no other means and there can be no doubt that the specific consumption of coal, (per h. p. installed etc.), will be very much less in future than in the past. Railway schedules are being carefully revised and a great reduction in idle mileage will ensue. As a result of the fuel economy in every field, miners will probably have substantial reasons to rue their folly and there is no doubt that the guaranteed wage will lead many men to work one day less per week and incidentally give them one more free day in which to send their money. For sheer though not vicious extravagance, I know no class of workers to equal colliers.

Should it prove practicable to utilise Prof. Ramsay's startling proposal to burn coal beds as they lie using the gaseous products in central stations at the pit head, the state of the miners will indeed be parlous. This proposal is subject to obvious difficulties but it is being given trial in certain shallow seams. Oil firing and internal combustion engines have received an enormous impetus and the number of patents filed in this field of invention has recently shown an extraordinary increase. It is well to remember, however, that oil and coal supplies are considerably interdependent.

Electrical manufacturers have suffered with others the dearth in fuel and raw materials but central stations, being for the most part well prepared for the crisis, have experienced a great increase in demand, much of which will be permanent. Once normal conditions are restored, many firms which have hitherto relied upon private power plant will undoubtedly apply for central station supply.

In future, all industrial works and central stations in particular, will provide greater fuel-storage capacity than has been deemed sufficient in the past so that, while the specific size of prime movers decreases, the size of the coal yard per horse power supplied, will increase. It is more than likely that some degree of cooperation will be arranged between stations as regards the purchase and stocking of fuel and it has been suggested that groups of stations should acquire collieries but the latter course would hardly avoid the labor trouble at the root of the trouble. A more likely policy is to make it a penal offense to incite strikes in any public utility service, (electricity, gas and water supply), and to provide, in similar manner, against any concerted hold-up of the nation by a single body of workers.

At the beginning of this year, engineering trades had embarked on a boom which had hardly been equalled during the past 40 years but for months perhaps years-to come, we shall feel the effects of this disastrous strike. Peril and paralysis have been imposed on every phase of our national existence and the efforts have been felt from our Navy and railroads to our bakeries and coal meat stores. Our immediate losses have been enormous and it is to be feared that much trade has been permanently sacrificed but the most pitiful of this, aptly termed, selfish strike, which has also proved a useless strike, is the severe hardship imposed on innocent workers and their dependants. In many cases their prosperity, dependent at the best on a small margin, can never be recovered and for a bare pittance is substituted grinding poverty.

Follow Up System of Wire Inspection.

Arrangements are being made for individual jobbers in various towns all over the country, to increase the value of the factory inspection service of the Underwriters' Laboratories by collecting samples of rubber covered 1911 code wire and sending same, together with reports covering points specified, to the New York office of the Laboratories at 135 Williams Street. The samples sent should be about four feet long, principally No. 14 and No. 12, with such occasional samples of larger sizes as special conditions may make advisable. Samples should be tagged with the following information: Date of manufacture, serial number of label and denomination of label, number of feet, and name of manufacture; all taken from tag on coil, and price at which wire is being retailed or wholesaled. All information of this kind received will be treated as confidential and followed up promptly as may be necessary, by a direct representative of Underwriters' Laboratories. Informal reports on samples received will also be arranged for.

Theater ceilings are usually decorated with paintings. These should have lights following the surrounding mouldings. Outlets under the balconies should be kept well to the rear, and those on the balcony lines should be on the face and not on the under edge.

Voltage Regulation and Calculation of a Two-Phase, Three-Wire System.

BY N. E. FUNK.

Abstracted for Southern Electrician by Author from Extensive Paper.

An Analysis of Conditions in Two-Phase Circuits with Vector Diagrams.

THIS article deals with the calculations involved in a two phase, three-wire system of distribution and the means used for maintaining constant voltage at the consumer's end of the line, and is an abstract of paper recently read by the author before the meter department section of the Philadelphia Electric Co., branch of the National Electric Light Association.

In view of the fact that vector diagrams are used and that the direction of the arrows in a vector diagram is the stumbling block of most students of vector analysis, therefore it may not be amiss to spend a few moments on this phase of the subject. The most simple method is to take any one point in the circuit and consider it the reference basis. Any currents flowing away from this point are considered positive, flowing toward it negative. Voltages above this reference point are positive ,below negative. Always draw the arrow on the end of the vector furtherest from this reference point. As an example the dotted line at the end of rIb in the schematic diagram of Fig. 2 is taken as the reference point. The arrow heads on all vectors must necessarily be away from this point. If the ends of ωLIc and ωLIa had been taken as reference points, all the vectors

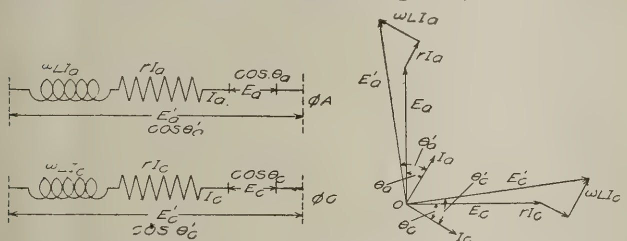


FIG. 1. VECTOR RELATIONS IN TWO-PHASE, FOUR-WIRE SYSTEM.

in Fig. 6 would be reversed but the resulting value would be the same. The matter of choosing a reference point is merely that of locating a point that is most convenient in laying off vectors, but any point will do as the analysis depends upon the relative and not actual location of the various quantities in the problem.

The voltage of self-induction, e_1, is 90° in time phase behind the current I producing it. The voltage, e_2, necessary to overcome the voltage of self-inductance is 180° from e_1, in time phase, therefore e_2 must be 90° ahead of I in time phase. For this reason the voltage necessary to overcome the self-induced voltage of the line ωLI is drawn 90° ahead of the line current I.

TWO-PHASE, FOUR-WIRE SYSTEM.

In this case there is no interconnection between phases and each phase may be replaced by a concentrated inductance and resistance as shown in Fig. 1. In the vector diagram of this system shown in Fig. 1, Ea and Ec represent the voltage of the A and C phase at the load. Ia and Ic are the load currents and are drawn at an angle $\Theta a + \Theta c$ behind the load voltages where Cos Θa and Cos Θc are the power factors of each phase.

From the end of Ea draw rIa parallel to Ia and equal to the voltage lost in the line resistance. From rIa draw ωLIa 90° ahead of Ia and equal to the voltage lost in line inductance. E'a is the necessary voltage at the generator end of the line to maintain voltage Ea at the load. The C phase vectors are constructed in the same manner. It will be noticed that under balanced conditions, the angles and vector values are the same in both phases, therefore, the angle between the resultant voltages will be the same as between the initial voltage, that is 90° and there is no dephasing action.

TWO-PHASE, THREE-WIRE SYSTEM.

In the two-phase, three-wire system, however, the relations are not so simple since there is a common connection between phases which carries a current that is lagging to one phase and leading to the other, which in itself is bound to disturb the angular relation of the resulting voltages. Since in this case voltages at the generator end are known to have a fixed 90 degree relation we will begin our solution with the generator end and work toward the receiver. This in itself shows the difficulty of accurately calculating the voltage relations in a two-phase, three-wire system because

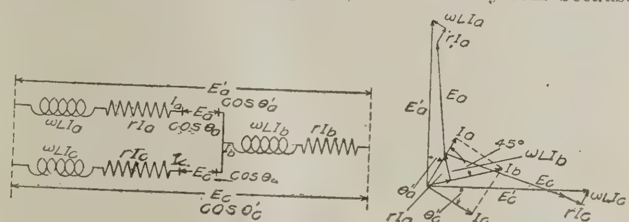


FIG. 2. VECTOR RELATIONS IN TWO PHASE, THREE-WIRE SYSTEM.

we do not know the value of the current or power factor at the generator end of the line until we find the voltage at the receiving end. This cannot be found until the line loss and dephasing angle are known. The line loss is not known until the line current and power factor are known, that is, the line loss is unknown until the voltage at the receiving end of the line is known. Therefore, since line loss and receiver voltage are both unknown, it is impossible to find either without first assuming one, making a trial solution for the other and so continuing until fairly accurate results are obtained. By solving a two phase three wire line as though it were a two-phase four-wire line and neglecting the dephasing action, a value of voltage loss will be obtained which is equal to the average of the accurate losses. The loss will always be greater in the leading phase and lesser in the lagging phase of a two phase, three wire system.

Let us now construct the vector diagram of the two-phase, three-wire line, Fig. 2. Draw E'a and E'c to scale of generator voltages and 90° apart. Draw Ia and Ic to

scale of load current and Θ'° behind E'a and E'c in phase, where cos Θ' is the power factor at the generator end of the line. Draw Ib, the resultant of Ia and Ic. Draw $_\omega$LIa and $_\omega$LIc to same scale as E'a and 90° ahead of Ia and Ic in phase. These vectors represent the voltages consumed in the induction losses in the outside wires. Draw rIa and rIc to the same scale as E'a and in phase with Ia and Ic. These vectors represent the voltages consumed in the resistance losses of the outside wires, and are drawn from the ends of the inductance loss vectors, Ea and Ec are the unknown quantities, therefore, they must be omitted in the voltage given in the diagramatic sketch of the line, and we pass on to the loss in the "b" wire, and work back to the voltages Ea and Ec.

From O, draw rIb to the same scale as E'a and in phase with Ib, the current in the common wire. This is the voltage consumed in the resistance loss of the common wire. Draw $_\omega$LIb to the same scale as Ea and 90° ahead of Ib. This represents the voltage consumed in the inductive loss of the "b" or common wire. If we draw the line Ea from the end of the vector $_\omega$LIb to the end of the vector rIa, the voltage at the receiver is obtained both in value and phase. likewise the line joining the ends of the vector, $_\omega$LIb and rIc represents the phase relation and value of the C phase receiver voltage Ec.

It will be noticed that the voltage Ea and Ec are not equal, nor are they 90° apart demonstrating that even with balanced conditions at one end of the line it is impossible to have balanced relations at the other end.

METER UNBALANCING.

There are times when two single phase wattmeters are used to measure the power consumed by a motor load that one of these meters will rotate backward. To better demonstrate this condition some measurements were made in a small two phase motor, one phase of which was disconnected from the line after the motor has been brought to full speed. By disconnecting only one side of the unloaded phase from the supply circuit we can determine the emf. induced in it with respect to the supply voltage. Fig. 3 shows the voltage measurements taken, and Fig. 4 gives the vectors from these measurements.

Checking up the values of 155, 110 and 109, we find

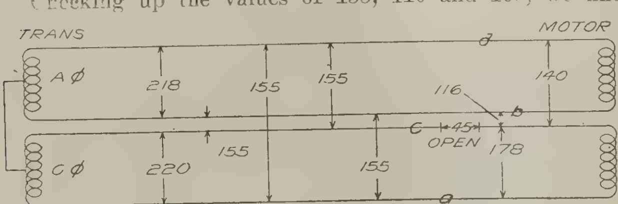


FIG 3.

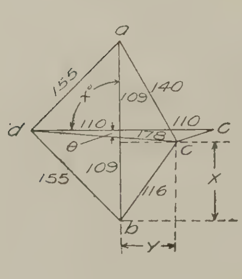


FIG. 4.

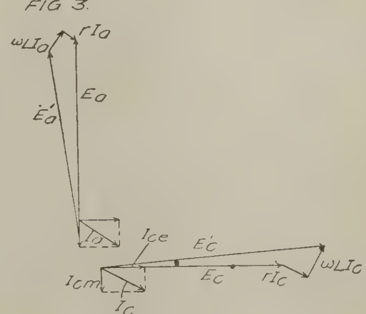


FIG 5.

FIGS. 3 AND 4. VOLTAGE MEASUREMENT AND VECTOR RELATIONS, FOR UNBALANCED CONDITIONS.

FIG 5. VECTOR RELATIONS FOR CONDITIONS IN FIG. 3.

that the angle x is practically 90°. To find the angle Θ, the triangle dec will be used and then this value will be checked by finding x and y from triangle abe and solving the right triangle thus obtained.

From trigonometry $\text{Cos } \Theta = (a^2 + b^2 - c^2)/2\ ab$ where a and b are the sides enclosing the angle Θ, and c is the opposite side.

$\text{Cos } \Theta = (220^2 + 178^2 - 45^2)/(2 \times 220 \times 178) = .9966$

$\text{Cos}^{-1}(.9966) = 4° 44'$

$X = (a^2 + b^2 - c^2)/2a$

$X = 218^2 + 116^2 - 140^2)/2 \times 218 = 94.9$

$Y = \sqrt{(116^2 - 94.9^2)} = 84.5$

$\text{Tan } \Theta = (109 - X)/(110 + Y) = 14.1/194.5 = .07249$

$\text{Tan}^{-1}(.07249) = 4° 9'$

The error of 35' is due to inaccurate voltage measurements as no special care was taken in obtaining them. Nevertheless the result desired is given, that is, the voltages produced in an induction motor tend to preserve their angular relation whether the motor is magnetized on both or only one phase. The slight dephasing of 4° + is due to the inductive loss in the running phase and the leakage inductance of the motor.

The low value of 178 volts obtained on the idle phase is due to the fact that the magnetic flux must travel through a much larger path to reach the iron on which this phase is wound and in consequence the leakage is much greater, also the counter emf of the running phase is less than the line voltage by the losses in the motor and this condition is reflected in the idle phase. We will now proceed with the vector analysis of the problem. Each phase will be shown separately to eliminate confusion.

In Fig. 5, the A phase is shown less than the voltage necessary to overcome the counter voltage of the motor, since this is the case, and since current will flow from the higher to the lower voltage it stands to reason that the current must flow from the motor to the line. Therefore, Ia must be at an angle greater than 90° from Ea. By constructing the vectors for inductance and resistance losses as before we obtain the vectors for the A phase.

The C phase line voltage is greater than the counter emf. of the motor, hence, the vector diagram will be constructed the same as Fig. 1. It will be noted that while the load current of the C phase, "Ic_1," is in phase with the voltage necessary to overcome the counter emf of the motor, and hence shows consumed power, the load current of the A phase is 180° out of phase with the voltage necessary to overcome the counter emf. of the motor and indicates power delivered. Iam and Icm are the magnetizing currents for each phase. This trouble will occur in any polyphase system where voltages are badly unbalanced in value.

The vector diagram shows in a general way the cause of the meter troubles sometimes experienced. A more complete solution would require an investigation of all the leakage, rotational and induced fluxes in the motor and inductance voltage losses in both stator and rotor and would be beyond the scope of this paper.

THE COMPENSATOR.

In the first part of this paper the losses that occur in transmission lines were shown. There are two other factors that have been omitted as they needlessly complicate the problems we are considering. These factors are charging current and leakage current, which on lines of moderate length and voltages less than 10,000 are so small that they

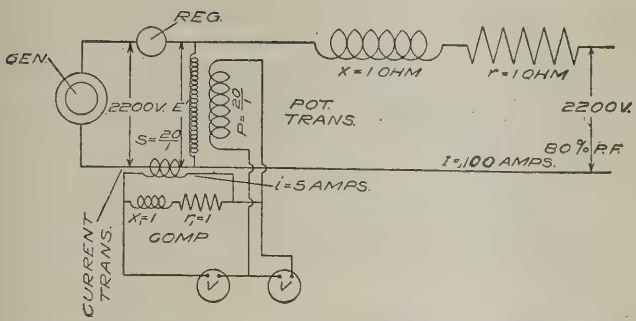


FIG. 6. ELEMENTS OF SINGLE-PHASE TRANSMISSION LINE.

would effect the result by less than one-half of one per cent. Let us now consider how these losses are overcome in practice so that we are able to give the consumer constant voltage. The first method taken up will be that of the Westinghouse Electric and Mfg. Co., type of compensator.

Fig. 6 shows a 2200 volt single phase transmission line having a resistance of 1 ohm and a reactance of 1 ohm, the load carried being 100 amperes at 80 per cent power factor. It is desired to obtain the voltage E′ that must be maintained at the station to deliver 2200 volts to the consumer. Construct Fig. 7 as follows: Draw a line Oa proportional to the voltage at the receiver (2200 volts). At an angle Θ (where $\cos\Theta = .8$) from this line draw a line oI proportional to 100 amperes. The resistance voltage loss is 1 ohm x 100 amperes = 100 volts. Draw a line ab from the end of oa parallel to oI and equal to 100 volts to the same scale as oa. The inductance volts loss is 1 ohm x 100 amperes = 100 volts. Draw to scale bc, 90° ahead of oI, and equal to 100 volts.

$$\text{Cos } \Theta = .8 \quad \text{Sin } \Theta = .6$$
$$X = ad + de = ad + bf$$
$$O = 100 \times .8 + 100 \times .6 = 140 \text{ volts.}$$
$$Y = cf - ef = cf - bd$$
$$Z = 100 \times .8 - 100 \times .6 = 20 \text{ volts.}$$
$$E' = \sqrt{[(oa + x)^2 + y^2]}$$
$$= \sqrt{[2340^2 + 20^2]}$$

Since the square of 2340 to the square of 20 bears the ratio of five and one half million to four hundred, we can neglect the 20 volts and call E′ = 2340. Therefore $\Theta' = \Theta$ practically.

The voltage read on the voltmeter V′ will be 2340/20 = 117. This will not be the voltage read on voltmeter V since the voltage produced in the compensator inductance and resistance is introduced in the voltmeter circuit so that it opposses the potential transformer voltage.

The ratio of the current transformer is 20/1, therefore, the current in the compensator is 100/20 = 5 amperes. The inductance voltage and resistance voltage are each 1 ohm x 5 amperes = 5 volts. Fig. 8 shows the vector relations in the secondary circuit. Draw oa proportional to 117 volts; draw oi proportional to 5 amperes and at an angle Θ to oa ($\text{Cos } \Theta = .8$); draw ab 90° ahead of oi and proportional to 5 volts; draw bc parallel to oi and proportional to 5 volts; oc is the voltage read on voltmeter V.

$$X = ed + dc = bf + dc$$
$$X = 5 \times .6 + 5 \times .8 = 7 \text{ volts.}$$
$$Y = af - ef = af - bd$$
$$Y = 5 \times .8 - 5 \times .6 = 1 \text{ volt}$$
$$e = \sqrt{[(oa - X)^2 + Y^2]}$$
$$e = \sqrt{[(117 - 7)^2 + 1^2]} = 110 \text{ volts.}$$

Therefore Y may be neglected and e = 110 volts, 110 × 20 = 2200 volts. That is, the voltmeter V will read the voltage at the receiving end of the line irrespective of power factor or load.

Suppose we attach contacts to the voltmeter so that when the voltage is higher than 110 the upper contact closes and causes the regulator to lower the voltage and vice versa. That means that the voltage at V must always be 110 and we have proven that when the voltage at V is 110 the voltage at the consumer is 2200. Therefore, the voltage at the station will always be maintained at such a value that correct voltage is delivered at the load.

Another means of controlling protential regulators is simpler but not as effective on circuits where there is a considerable variation in power factor. A design of this method is shown in Fig. 9, and is the theory on which the General Electric contact making voltmeter is based. By using a compensator in the potential circuit of this contact making voltmeter and cutting out the current coils, this type of apparatus may be made to take care of any power factor in the same manner as was shown in Fig. 6.

The explanation of Fig. 9 is given as follows: The

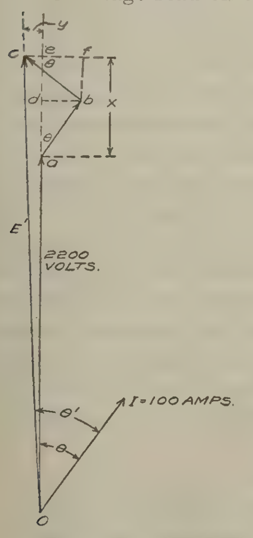


FIG. 7.

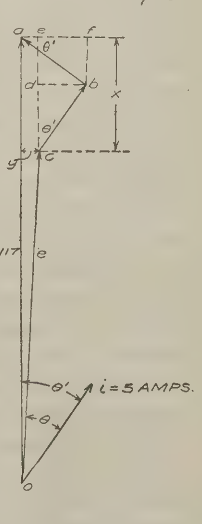


FIG 8

FIG. 7 AND 8. VECTOR RELATIONS FOR CONDITIONS IN FIG. 6.

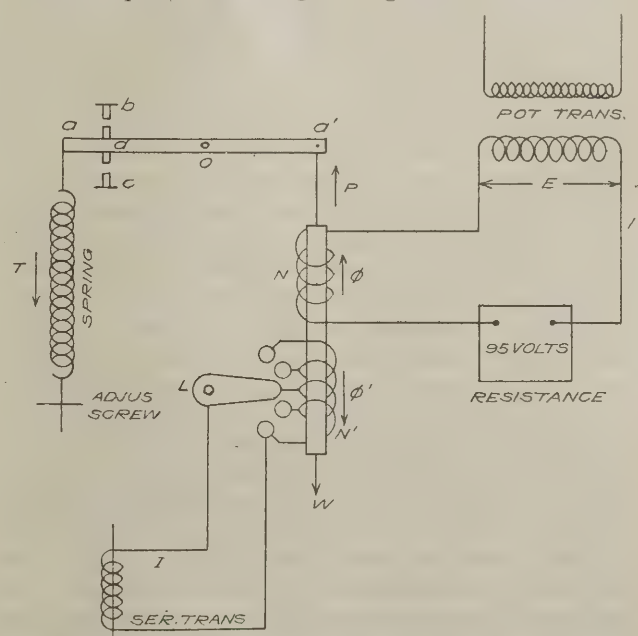


FIG. 9. ELEMENTS OF A POTENTIAL REGULATOR.

Arm aa' is hung at the point, 0, on a shaft that moves in bearings specially designed to eliminate friction. The moving contact "d" is connected to one side of the secondary control supply circuit through a very flexible spiral of wire. The points b and C are each connected to a magnet in such a manner that when b and d make contact the magnet is energized which closes the motor circuit and causes the regulator head to rotate in a direction that raises the circuit voltage. When c and d make contact the direction of rotation of the motor is reversed and the circuit voltage lowered.

REFERENCES.

"Power," September 14, 1909, p. 144.
"Elec. Review and Western Electrician," July 31, 1909, p. 194.
"Electric Journal" (Vol. II), p. 361.
"Electric Journal" (Vol. IV), p. 137.
A. I. E. E. (Vol. XXVII, Part II), p. 1397.
A. I. E. E. (Vol. XXVII, Part I), p. 1231.
A. I. E. E. (Vol. XXVIII, Part I), p. 615.
A. I. E. E. (Vol. XXVIII, Part I), p. 641.
A. I. E. E. (Vol. XXVIII, Part I), p. 703.

Some Interesting Points Concerning Transformer Operation.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY JAMES A. SEAGER.

IN the operation of transformers of the static type for ordinary conversion of pressure to distribution voltage for house supply, there may appear to be very few troubles which are likely to arise from apparatus which is now so thoroughly standardized and which by its simplicity of construction and absence of moving parts seems to promise the utmost fulfilment of conditions of automatic operation. At the same time every engineer in an alternating current supply system will have cases arise where even with the static transformer it is necessary to exercise some discrimination as to the way the troubles should be treated and it may be worth while in view of the tendency today of assuming that electrical apparatus is becoming so automatic as to do away with the necessity for a skilled engineer in attendance, to make mention of one or two examples of partial or total breakdown occurring in connection with static transformers.

Difficulty occasionally arises in connection with alternating current supply systems where transformers of different types and makes are used for a parallel supply. That is to say, one which takes high tension current from the feeder system and converts it by transformers in parallel to the same system of secondary distribution. Both the transformers may be rated for the same ratio of conversion, but it not infrequently happens that they have different characteristics from each other at the various points of their load curve. The result of this is that while on light loads or medium loads they may each take their proper proportion of the total load, it will be found that at full loads or over loads one transformer may have a larger internal drop of pressure than the other with the result that the loads between the transformers get out of balance, one transformer picking up a good deal more than its share and therefore tending to overload and overheat itself while the other does not do its proper amount of the work. In one such instance where this was noted but where it was impossible to take the transformers out to adjust them, so as to get equal loading, a simple device was hit upon which may be of use to engineers faced with the same difficulty. The virtual resistance of the high tension coils of one of the transformers was increased by taking a coil out of an arc lamp transformer and arranging it on the top of the transformer in series with the high tension circuit. The coil was of large enough cross section to take the full load current required by the transformer. Care should, however, be made in effecting an adjustment of this kind to see that the additional coil is very well insulated from earth, and also that it is surrounded by incombustible material. The reason for this is that as a rule such transformers as are used for arc lamp service may not be sufficiently well insulated to withstand the total supply voltage on the high tension side with the result that should the high tension winding of the transformer be comparatively slow in building up its counter-electro-motive force, the series coils will be subjected to the full working voltage at the instant of closing the circuit on the primary of the transformer, and unless means are taken to prevent it there may possibly be a heavy flash from the series transformer coil to earth. There may be also somewhat similar trouble when switching off owing to the inductive kick of the circuit.

One of the most usual causes of trouble in connection with static transformer practice is that attendants who ought to know better will, unless they are carefully watched, fuse up the primary or secondary sides of the circuits far beyond their proper strength probably with the idea of saving themselves trouble owing to overloads or even possible temporary short circuits on the low tension supply system. Anyone who has had practical experience in connection with such transformer systems will know how very real this danger is and it should be a matter of systematic routine to inspect frequently every fuse in connection with the transformers and the supply system in order to see that they are of the proper strength. In one case a very bad accident which seriously endangered the whole lighting supply of a town occurred through defective fuses of this nature. A short circuit developed on one winding of a transformer which was one of three working in parallel and feeding a 3-wire network. The low tension fuses did not blow, owing, it was believed, to their being too large, with the result that the other transformers fed into the defective one and completely destroyed the windings. In addition to letting the voltage go down on the secondary network, therefore, the supply system was subjected to the expense of obtaining a completely rewound transformer as the result of the neglect of a little care in seeing that the fuses were of the proper strength.

Another piece of routine work which should be most carefully attended to in connection with transformers is to see that whenever the high tension switches and fuses of a transformer on an inter-connected system have been open

circuited, the low tension switches should never be left closed. It should be made a rule that when disconnecting a transformer from circuit, the low tension switches or plugs should be withdrawn first, otherwise, there is not only danger of arcing, but what is perhaps even more serious, the high tension transformer terminals may be assumed to be dead when as a matter of fact they are very much alive. On one occasion an accident which might have been fatal was only just avoided, and this had its root in the neglect of the precaution above described. A workman was engaged in effecting some minor repairs to a transformer and having seen that the high tension switches were open and fuses drawn, was about to disconnect the cables between the transformer and the fuses on the high tension side, forgetting that other transformers were feeding back through the low tension connections and producing a potential on the high tension side of the transformer equal to the high pressure supply voltage. Fortunately some one else who was near noticed the danger and dragged the man back before he killed himself. The incident, however, served to emphasize the necessity for stringent observation of the rule given above.

The natural and obvious way to switch a transformer into open circuit again is first of all to put in the high tension fuses and then to close the switches on the high tension side, and afterwards to close the transformer on the supply system on the low tension side. As a matter of fact, however, it has been noticed on several occasions that when this is done and when both the low tension switches are out, a large arc will form between the jaws and blade of the switch on the high tension side on the instant of completing the circuit. It is rather difficult to see why this arcing should occur, but one theory which may be advanced and which probably holds good for some types of transformers utilizing certain qualities of transformer iron, is that this transformer arc is caused by the remanent magnetism in the core. Supposing that at the instant of switching out the transformer, the current was flowing through the windings in what we may call a positive direction, and then assuming that on switching in, the current was then flowing in a negative direction, it is possible to conceive that the extra work necessary in reversing the magnetism of the core may produce the flash. This is only a practical working theory which may be disapproved by a mathematician, but the fact remains that with some transformers this flash has been observed not once, but repeatedly.

There are other rather curious phenomena in connection with switching in of transformers which the writer has not been able to explain satisfactorily, but it is hoped that some readers of these notes may be able to furnish a good working theory. For example, a small transformer was burned out and the engineer in charge of the equipment opened the high tension side of the transformer and tested the low tension side by putting in plugs on the low tension board with a light fuse in one of them. The fuse promptly blew, and the engineer assumed that only the low tension coils were affected, but in order to make sure he tested the high tension side the same way. He pulled out the low tension plugs and put in one high tension feeder plug. The supply by the way, was by a concentric system of cables, and the plug mentioned above was on the outer and was fused with four strands of No. 30 gage copper fuse wire. He then made up a light fuse consisting of one strand of No. 30 copper wire on the inner plug on the high tension side and pushing in the bottom contact of the inner plug he just made touching contact with the top of the plug. Immediately after the circuit was completed, that is to say, the instant of touching, not drawing away, an arc flashed across from the bottom to the top contact of the plug on the inner side and flamed about five feet above the top contact. The distance between the two contacts was about 5 feet, so that the discharge and flame together were about 10 feet long. The engineer pulled the inner plug away at once, but the discharge continued until he had drawn the outer plug as well. Now, both the low tension plugs were drawn at the time and the fuses in both high tension plugs on examination afterwards were found to be unaffected. The discharge had apparently ignored the light fuse in the inner plug altogether. The normal high tension voltage was 3,000 volts, but for some reason or other at the instant that this happened the voltage must have been at least doubled across the contacts of the inner plug. Possibly the instance may have been due to some induction effect, but it certainly requires some further explanation which the writer is unable to supply.

In another case where a transformer of small capacity had been working perfectly satisfactorily one of the high tension plugs was drawn from the transformer at a time when the low tension plugs were left in, that is to say, the circuit was first broken on the high tension side. The action of the discharge was the same as described above, but in this case the arc did not flame so high as in the previous example. The attendant who had drawn the plug on the inner pole of the high tension was rather startled at the incident, and it did not occur to him at the moment to withdraw the high tension plug on the outer. The result was that the arc persisted and melted the top contact of the inner plug.

In conclusion a note may be made with regard to a property which has been noticed in some transformers which seriously militates against their use on occasional service, although they are perfectly good for long continuous runs. Here, again, some theoretical explanation appears to be wanting. It has been noticed as a matter of fact that some transformers appear to offer difficulties to being brought into step again if they have been disconnected from the supply system. There appears to be a considerable amount of electric inertia about them and they have frequently been found to take several minutes to pick up their load, although after they have done so they operate perfectly steadily and satisfactorily. This may possibly be due to some peculiarity in the quality of the iron used, but whatever the cause may be it has not, so far as the writer is aware, been determined, and suggestions on the matter would be valuable.

The above notes are by no means of the instructional character which usually appear in technical papers. They are simply the outcome of rough notes made in the course of practical operating experiences and some of them have not even the merit of a scientific explanation attaching to them. At the same time it is thought that the publication of crude experiences may be of advantage from the point of view of discussion, inasmuch as what is one man's difficulty is evident confirmation of another man's experiences, and in this way the practical science of plant operation is gradually built up. It is from this point of view that the above notes are offered for discussion.

The Use of Graphic Recorders to Increase the Production of Electrically Driven Plants.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY H. W. YOUNG, ASSOC. MEMBER A. I. E. E., AND PRESIDENT OF DELTA-STAR ELECTRIC COMPANY OF CHICAGO.

As the selling price of a manufactured article is eventually fixed by competition and the tendency towards lower prices, the manufacturer in order to obtain a legitimate profit on his product must reduce the cost of production or in other words, increase the plant efficiency. While the total cost of power may be large in dollars, it is in reality a very small percentage of the cost of production, so that any effort along the lines of saving power will have a far less effect on production costs than the same effort expended to secure full production from the machines.

As is well known, the mechanical output of an electrically driven plant, is almost directly proportional to the electrical input, so it can easily be seen that unless the motors are consuming power, the driven machines are not turning out product. The ideal conditions would be to have each machine operating at a maximum load without variation or shut-down during the entire working day, as this would give maximum production.

As a basis for securing maximum production from a given equipment, it is necessary that exact knowledge be had of the existing conditions; and for this purpose no instrument is so useful and valuable as the portable graphic recorder of either the ammeter or wattmeter form. By connecting a graphic recorder in series with the motor operating a driven machine or group of machines, a record will be obtained showing the load curve. Assuming that under full production a given machine requires 10 kw. of power and the graphic wattmeter shows that it has been taking 8 kw., this would be conclusive evidence that the production were less than the maximum and could only be increased by increasing the consumption of current, bringing the load curve back to 10 kw.

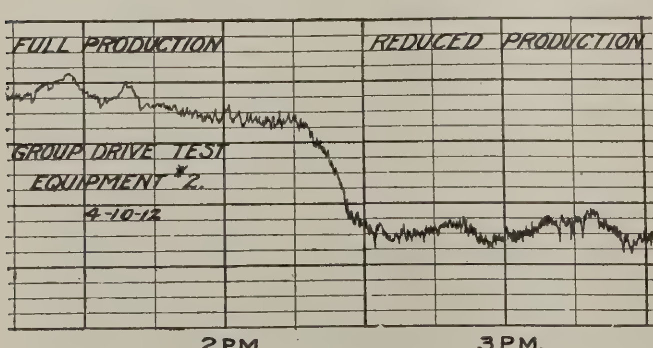
In fact, the load curve of a direct connected motor installation, of a group drive or of the entire plant, can be accepted as a direct indication of the rate of operation or production. When the load curve traced by the graphic meter falls off, it is certain that the machine or plant is not working under full capacity and there is a decided loss in productive output. It is usually difficult to quickly assign the reason for diminished production of an electrically driven plant unless a graphic is used as any other method requires the service of several men to observe, tabulate and interpret the readings of indicating instruments. The latter method of securing data is open to the objection that the operatives' attention is immediately attracted to the fact that something unusual is going on and as a result the test is not conducted under normal conditions. The graphic recording method, on the other hand, has a decided advantage of being automatic, secret, and eliminates the personal equation.

The most effective method of correcting trouble is to localize it and in an electrically driven plant the graphic can be connected to different feeders or motor circuits, the faulty ones detected and proper corrective methods applied. When discussing the question of operating costs of electrically driven plants, it must be remembered that the quickest way of securing economy is to increase the percentage of the total time consumed in actual productive work. The overhead charges and machine hour costs go on whether the equipment is running or idle and these charges are a large percentage of the total cost of production. As a rule the average plant owner however places too much importance on the cost of power constantly seeking to see how much power can be saved.

The ideal method is to use all the power that can be utilized in keeping the driven machines loaded with work, every possible minute of the working day. This condition cannot however be reached by the ordinary method of timekeepers, to see that the operatives report on time or actually remain at their posts until closing time. What is needed is an automatic disinterested and reliable recorder, the record of which is a direct measure of the time of working and the degree to which the machine is working. The electrically driven plant is peculiarly well adapted to utilize such a system as with a graphic recorder the manager has an unimpeachable record of just what occurred and when. For a given expenditure this method will effect greater economies in a shorter period than any other which has come under the writer's observation.

As an example of information given by graphic recorders, reference should be made to the accompanying illustration showing the power consumption of a group of motor driven machines. It will be seen that from 1 p. m. until 2:15 p. m. the machines were operating at practically full production, as the kw. curve held a good average. During the next fifteen minutes there was a great falling off in current consumption showing a corresponding decrease in production, so that from 2:15 p. m. the machines were only operating at approximately 50 per cent capacity.

While such operation may be satisfactorily explained by local conditions, yet the graphic recorder curve places the facts before the management in a clear easily understood manner, so that if corrective measures have to be applied there is some real basis and evidence on which to work.



A PRODUCTION CURVE BY A GRAPHIC RECORDER.

In case of any burn-outs in a transformer the oil should be renewed whenever new windings are put in place. Transformer oil should not be subjected to great changes in temperature, owing to the fact that moisture is likely to get into same, owing to the "sweating" of the containing case. When cold, the dielectric strength of transformer oil is somewhat decreased.

Transformer oil is obtained by fractional distillation of petroleum unmixed with any other substances and without subsequent chemical treatment.

Southern Convention News.

Fourth Annual Convention of Mississippi Electric Association.

The fourth annual convention of the Mississippi Electric Association, a state section of N. E. L. A., was held at Vicksburg, Mississippi, May 28 to 30, 1912. The work of the association at this convention as well as during the past year will go on record as representative of the real good an organization of active central station men can do. The members of the executive committee have been inspired by the work accomplished in their state during the past few months through the existance of the body in regard to legislative matters effecting the central station business and the convention took on an aspect of real earnest association work immediately upon the opening of its first session. The executive committee came to Vicksburg convinced that more work could be profitably done than in past years, and the program was layed out in such a way that every Class A and B member was engaged during the entire three days of sessions. The convention therefore was truly a working convention as the following review will indicate .

The registration bureau during the convention was located in the office of the Vicksburg Light and Power Co., and the sessions held at the city hall, at which there was at each meeting an enthusiastic attendance. The total registration of members and guests attending the convention was 106. As the membership now stands the classification is as follows: Class A, 14, Class B, 25, Class C, 2, and Class D 73, making a total of 114.

TUESDAY SESSIONS.

The convention was called to order promptly at 9:30, Tuesday morning, by Vice-President R. B. Claggett, of the Delta Electric Light, Power and Mfg. Co., of Greenville, who explained that President Abbott would not be in attendance on account of his connection with another company taking him from the State. Mr. Claggett then introduced Honorable J. J. Hayes, Mayor of Vicksburg, who welcomed those in attendance and expressed the pleasure it afforded him as Mayor to extend the hospitality of the City to a body engaged in such useful and beneficial work. He related the interest he had always felt in electricity from the time when, as Captain of a Mississippi river steamboat, he made use of the first electric search light for the purpose of locating landing places along the river banks. Mayor Hayes remarks were well received and Vice-President Claggett gracefully acknowledged same on behalf of the Association and then proceeded to deliver his address as acting president.

Vice-President Claggett in his remarks dwelt on the work of the past year, and outlined the history of the association since its organization in Jackson, June 1909. The early membership was small and at first but little enthusiasm was manifested, yet the few who realized the benefits to be derived from such an organization, by constant effort have seen the membership increase until now it compares favorably with similar organizations elsewhere.

He referred to the work of the Question Box, as a means of activity for all the members, and stated that it should be one of the important works of the Association. Current questions could be handled to better advantage, useful data placed in hands of members and its facilities would serve for communication between members. He was firmly convinced that it would become a great factor in the Association. At the last executive session arrangements were made for carrying on the work of the Question Box through Southern Electrician, the association's official organ. Prof. C. E. Reid will be question box editor.

Speaking on standardization of accounts, he said that a committee should be appointed to consider the adaptibility of the forms prescribed by the National Electric Light Association. Should time come when member companies are subject to rulings of a Public Utility Commission, we should be in position to convince them of the practicability of the forms recommended.

Regarding proposed legislation, he stated that the electrical industry had developed so rapidly that central station managers have had no time to watch legislative matters, resulting in a condition which poorly protects the interests involved. A number of important laws should be enacted, among which is one dealing with the theft of current, making the presence on any premise of any appliance or other device for purpose of deflecting flow of current, prima facie evidence, putting burden of proof on the occupant of the premises.

On account of neglect of legislative matters, much unreasonable legislation is often proposed. During the past year the central station interests of the State were subjected to the results of an agitation coming from an indefinable source, having for its object the creation and establishment of laws and commissions which would regulate and control the business of the central stations and some bills introduced were no less than confiscatory had they passed. The Executive Committee appeared before the Senate Judiciary Committee of the Legislature and discussed thoroughly the merits and demerits of the proposed legislation. The results achieved were beyond the Executive Committee's expectation, but had it not been for the concentrated effort on the part of this association, the central stations of the State would, in all probability, be subject to rulings of a commission whose members would be unfamiliar with subjects in hand. We do not oppose a "Public Utility Commission," he said, but demand one free from politics, with adequate legislation protecting the interests at stake so that business can be carried on in peace.

He commended the practice of frequent meetings of the executive committee, and thanked Mr. W. B. Moorman, of Vicksburg, for careful plans for the convention.

Following the President's Address, the first paper on the program was presented by H. W. Young, president, Delta-Star Electric Co., Chicago, who explained that the author, Mr. R. C. Lanphier, was unavoidably detained. This paper was listened to with a great deal of interest. An abstract follows:

THE DEVELOPMENT OF INDUCTION METERS AND FEATURES OF SOME PRESENT TYPES.

Mr. Lanphier traced the development of the induction meter during the past twenty-four years, stating that the fundamental principle on which the induction watt hour meter operates,

was discovered or announced by Prof. Gallileo Ferraris, at Turin, Italy, in the latter part of 1887 or early in 1888. In simplest terms, the Ferraris principle, or as it has also been called in this country, the Tesla principle, is, that a metallic rotatable body, suitably disposed to two alternating fields of different phase, or time relation, will be set in rotation by the interaction of these fields.

The first induction meter of which there is any record of importance, is one produced by Borel & Paccaud, in 1888, this meter having had a cup type copper armature with a pair of fields; one series and one shunt, placed on cores at right angles, and acting upon the armature. During the succeeding three or four years, a great deal of development work was done by Ferraris, himself, by Blathy in Switzerland, and by Shallenberger, Tesla, Gutmann, Slattery, Duncan and Scheefer in this country.

While we have spoken so far of the Ferraris principle as applied to a watt-hour meter, it should be stated that the earliest work, particularly in this country, during the period referred to, was on an ampere-hour or lamp hour alternating current meter, rather than a watt-hour, or energy meter. These ampere-hour meters operated on the split phase principle, but the two fields of different phase were not obtained by having both directly connected in or to the circuit, as in a watt-hour meter. In the ampere-hour, or lamp-hour meter, the Shallenberger may be considered as a characteristic type. These old Shallenberger ampere-hour meters were quite generally used until the introducction of watt-hour meters, ten or twelve years ago. In addition to the Shallenberger induction ampere-hour meter, which was brought out by the Westinghouse Company about 1889, a quite similar meter, the Slattery, was made by the Ft. Wayne Company in 1890 and 1891, and this was further improved upon by Thomas Duncan, and was made by the Ft. Wayne Company under the name of the Duncan Lamp-hour or ampere-hour meter, until 1896 or 1897. Up to 1896, no commercially practical or successful watt-hour induction meter had been brought out in this country, and the attempts made abroad had been confined principally to the Borel & Paccaud, and one or two other types which had a very limited sale.

In 1895, Shallenberger discovered or invented the method of compensating a watt-hour meter for inductive loads, which has since been employed in practically every successful induction meter made. The application of the Shallenberger principle in a watt-hour meter is usually spoken of as "compensation" or "quarter-phasing," and when a meter is compensated properly it will record true energy.

Following the discovery of the above principle by Shallenberger, the first so-called watt-hour meter was brought out in this country by Scheefer, in 1896. About 1898 a great many engineers were working on the problem of a watt-hour meter, as it had been realized by that time that the enormous growth in the use of alternating current which was then taking place, rendered it necessary to have meters which would fulfill the requirements better than the well known commutator type meter, or than the induction type ampere-hour meter. Incidentally, the Thomson commutator type meter had been on the market since 1888 or 1889, and had been used even more generally on alternating current circuits than the induction lamp hour meters, and in fact continued to be used quite extensively until nine or ten years ago. During the period, therefore, from 1897 to 1900, the induction meter had to fight its way against well established commutator meters, the later being pushed with all the influence of a large and powerful organization, which at first could see no possible merit in the induction meter. In 1897, the Westinghouse Company brought out their first watt-hour meter, this being the so-called Shallenberger type, and being the first meter to embody the principle of compensation for inductive load, invented by Shallenberger. It was followed in 1898 by the Ft. Wayne Duncan watt-hour meter, which at that time was undoubtedly the most advanced type of meter which had been put on the market.

In 1899 there was quite a deluge of new meters, including the original Gutmann cylinder type made by the Sangamo Electric Company, the original large Stanley type with magnetic flotation, made by the Stanley Instrument Co., the Westinghouse round pattern type "A," the original Thomson G. E. square type induction meter, and an improved type of Scheefer meter, made by the Diamond Meter Company. Of these meters, the Gutmann was quite different from anything previously produced, having two fields arranged so that they would not produce rotation with a plain aluminum cylinder, and the cylinder was therefore slotted in long spiral curves so that the secondary currents produced in it were guided between the fields in such a way as to give the same results as by having the fields themselves displaced.

In the two years following, that is, until the beginning of 1902, a great deal of progress was made in induction meters, and within this period the Westinghouse Type "A" was modified and made better, the Stanley meter was greatly reduced in size, and brought out in an improved and perfected form, still with the magnetic flotation bearing; a second Gutmann meter, the disc type, was produced and the original Ft. Wayne Type "K" meter was also put on the market about the beginning of 1901.

In recent years some very interesting applications of induction meters may be mentioned,—among these the metering of polyphase circuits and also the attempts to perfect and use a cyclometer or jumping type recording train instead of the usual dial with circles. Polyphase meters as now manufactured are simply two single phase meters combined, in fact, the majority of polyphase meters now on the market consist simply of two standard single phase meter elements mounted on one shaft, and acted upon by two complete sets of single phase fields suitably connected in circuit.

On a three phase system, either with lagging or leading load or whether the load is balanced or not, the true energy may be measured by two properly calibrated single phase meters, which are also accurately compensated on inductive load of low power factor. In some cases, particularly with very large or important loads it is better to use two single-phase meters than one polyphase, as trouble with the driving system of either meter will be promptly detected when two meters are used, whereas with the polyphase meter, the field element acting on one disc may go dead and the other motor element will continue to operate the meter, so that such a condition may frequently go some time without being detected until the difference in meter reading indicates trouble.

Mr. Lamphier's paper was discussed quite fully by Professor Reid and H. W. Young. Professor Reid dwelt on the great and sustained accuracy of induction meters, citing some tests made at Bureau of Standards at Washington, a number of years ago, in which he took part.

Mr. Young pointed out that the expiration of certain patents had opened the door to meter designers, and the present lower price of meters was the result. He stated that further reductions are not probable, that the central stations demanded a high degree of accuracy and on this account the overhead charges of the manufacturers were high.

A. H. Jones, McComb, pointed out that the central stations are not entirely to blame for the demand for accurate meters, at least, not in Mississippi, that we have here a factor, known as the consumer, which enters the calculation. This consumer is jealous of the treatment received and nothing but a meter of the highest accuracy will satisfy him.

The afternoon session was executive for Class "A" and "B" members at which was presented a paper on "Grounding of Secondaries" by J. T. Robertson, Electrical Engineer for Miss. Inspection and Advisory Rating Co. An abstract follows:

GROUNDED SECONDARIES OF HIGH TENSION CIRCUITS.

The Fire Underwriters have for a long time recommended the grounding of secondaries of alternating current circuits; but have not made it mandatory, in the National Electric Code. Grounding secondaries is considered primarily a protection to life and, under normal conditions, affording no additional protection to property. While on the other hand, we may have serious trouble arising from defective installations, such as short circuits and grounds, in defective electrical equipments.

At a recent meeting of the electrical committee, of the National Fire Protection Association, held in Boston, at which meeting were representatives of the American Institute of Electrical Engineers, The National Electric Light Association, The Association of Edison Illuminating Companies, The National Inspectors Association, the following rules were adopted, to be presented at the open meeting of the National Fire Protection Association to be held in March, 1913, and it is practically assured these regulations will be adopted. "Neutral wire must be grounded and the following rules must be complied with:

'Two-wire direct current systems having no accessible neutral point are not to be grounded.

'Transfermer secondaries of distributing systems must be grounded provided the maximum difference of potential between the grounded point and any other point in the circuit does not exceed 150 volts.

'When no neutral point or wire is accessible one side of the secondary circuit must be grounded.

'Where the maximum difference of potential between the grounded point and any other point in the circuit exceeds 150 volts, grounding may be permitted.

'It is recommended that departments in charge of waterworks be urged to allow the attachment of ground wires to their piping systems in the full confidence that the integrity of such systems will not be disturbed at the normal voltage, and that all concerned give careful thought to other methods of obtaining satisfactory grounds wherever this most necessary precaution of grounded secondary circuits may be available in all localities and under all conditions.''

The system of grounding must necessarily vary in different localities, on account of local conditions. The best and most approved method of grounding is to connect to the underground water pipe systems, at close intervals, with not less than No. 6 B. & S. gage copper wire properly protected. The system most likely to be adopted in case the water pipe system is not available, is a rod or pipe driven into the ground below the permanent moisture level connected with the neutral or one of the outside secondaries by a No. 6 B. & S. gage, or larger wire.

The National Electric Code requires grounding every 500 feet, but in case the rod or pipe method is used, I would say the grounds should be made about every 250 feet. From experiment it has been found the resistance of the grounds increase very rapidly when subjected to large currents. The grounding of secondaries to trolley rails is considered bad practice, and would not recommend it, except in extreme cases. There should be no trouble in obtaining a thorough ground anywhere in Mississippi, on account of character of soil, without resorting to use of any mineral salts, provided a sufficient number of pipes are used properly driven into the ground well below permanent moisture level. A number of light companies have already grounded their neutrals and secondaries, and from inquiries addressed to them, will say the majority report they have had no increase in operating troubles, and consider they are better protected against lightning.

This paper was discussed by H. W. Young, Chicago, Professor Reid, S. M. Jones, Laurel, T. B. Cabell, Jackson, A. H. Jones, McComb, R. B. Claggett, Greenville, W. H. Harvey, Winona. This discussion brought out the fact that grounding of secondaries is a source of much worry to all companies. The expense of the ground connection, also of the inspection, and the troubles from defective installations and grounds in trees were gone into thoroughly. Mr. H. W. Young, of Chicago, pointed out that in some cases a spark gap interposed in the ground circuit would oftentimes avoid the troubles due to poorly insulated systems, and would protect from high voltage.

The report of Secretary and Treasurer read at this session referred to work of the executive committee before the legislature, which was also mentioned in president's address. The conduct of this case before the Senate Committee and results obtained, have proved conclusively the value of the association, as well as the absolute necessity of the organization. A committee is recommended to gather information and statistics on Public Utility Commission matters and also to draw up a recommendation of a Public Utility bill, patterned after the best features of the laws of other States, so that the data and recommendations can be submitted to the Legislature when subject becomes active again. Experience prove sthat it is too complicated to be handled properly in the hurry of a legislative session.

It was pointed out that one feature of the work of the association had been neglected in that not enough committee work on part of members had been done. It was suggested that committees be appointed on public Policy, Line Construction, Insurance, Public Utility Laws, Meter Practice, Electric Heating and Cooking, Electric Vehicles, and Grounding of Secondaries. Reports of such committees would be an annual statement of the condition and progress of each in the State. Criticisms of National Electric Light Association reports could also be embodied in same, pointing out to members wherein local conditions demanded variations from the National recommendations.

The affiliation with National Electric Light Association was called to attention of members and necessity for change in membership classification to conform with the National.

A campaign for class "B" members was urged and thanks of secretary and treasurer for splendid spirit of cooperation manifested by each officer and member.

A statement of receipts and disbursements was submitted which was referred to an auditing committee and President's address, and Secretary's report, also referred to a committee for consideration and submission for recommendations.

WEDNESDAY SESSIONS.

The second day's session was called to order promptly at 9:30, and the first paper read by T. A. McDowell, who explained that the author, A. D. Fishel, of the Westinghouse Electric and Mfg. Co., was unavoidably detained. An abstract of the paper follows:

DISTRIBUTING TRANSFORMERS.

In this paper Mr. Fishel discussed briefly some phases of the distributing transformer and its application for lighting and power service. He stated that the transformer for central stations distribution service has been properly standardized to capacities, voltages and frequency. The normal distributing voltage is 2200 volts high tension with 110, 220 or 440 volts as low tension voltages. The standard frequency is 60 cycles, as the 125 and 133 cycles stations are rapidly being equipped with more modern apparatus.

The system of low tension distribution for light and power must be governed chiefly by local conditions. The service may consist of service in one section for lighting only, in another power only, and mixed service in others. Further, this service may be continuous or intermittent. The transformer installations for lighting service or dependent upon whether the district served is isolated or congested. Wherever several customers are close to each other, it becomes desirable to use larger transformers with a secondary distribution system. When the number, size and relative location of customers justify, this system is carried still further to install several transformers per block and place the low tension windings in multiple, forming a secondary distribution net work.

The secondary system can then be tapped for each consumer at a point nearest to his service box. Apart from the decrease in cost of transformers and fixed charge for transformer losses, an advantage exists in the non-interruption of service should the load from one consumer become excessive or should one transformer be disabled. With a severe short circuit, there enters the disadvantage of interruption of service to a large number of consumers, unless fuse protection is provided in the low tension side of the transformers, necessitating extra expense, as well as creating possibility, should some fuses blow, of overloading part of the equipment, as information can be obtained only by frequent inspection of fuses.

When operating transformers in parallel, it becomes essential that they should have the same ratio of transformation and desirable that their regulation should be as nearly alike as practicable. The standard transformers of reliable manufacturers do not differ very widely in impedance characteristics, however, and it is usually practical to operate various standard types in parallel, and often the commercial desirability of paralleling transformers of different sizes will overbalance consideration of some inequality in the sharing of the load which might result.

Both for 2200 volt class and for higher voltage distribution, consideration is sometimes given to the relative desirability of single- and threephase distributing transformers for 3-phase power installations. Three-phase transformers for 2200 volt, 60 cycle service are made in sizes up to 100 Kva., suitable for suspension from pole crossarms. For central stations of medium sizes, three-phase transformers are rarely superior, until the larger sizes are reached, where the transformers are normally installed in sub-stations or central stations. The chief reason is the non-flexibility of the three-phase transformers. It is naturally bought for a particular size and type of load, and if that load should be changed, the transformer, representing a comparatively heavy investment, remains on the hands of the central station, whereas the single-phase transformer of one-third the size, could usually be adapted for some other service. This feature becomes of less importance as the central station increases in size, and three-phase transformers for

purely power service are now being used in a considerable number of the large central stations of this country. The three-phase transformer costs less to install and the connections are simplified, points that are of importance in connection with outdoor installations.

The transformers placed upon the same feeder are usually of various sizes and types and would, therefore, have considerably different regulation values, even if the load conditions upon them were the same at similar periods. The variations in voltage due to the drop in the feeder can be satisfactorily taken care of only by the use of feeder potential regulators. The maintenance of a constant potential on the feeder system will result in increased sale of energy, increase in the economy of operation, decrease in number of lamp renewals, and improvements in the illumination with more satisfied customers. The increase in sale of energy alone will usually pay for the expenditure for an automatic feeder regulator in a comparatively short time. The average medium size central station considers the expenditure necessary for an automatic regulator to be excessive, but the increase in revenue due to the increased consumption of power by incandescent lamps would usually justify the investment from that standpoint alone.

This paper was briefly discussed by H. W. Young, Chicago, W. F. Cox, Natchez, A. H. Jones, McComb, W. F. Gorenflo, Gulfport.

The next paper was read by G. S. Merrill, rate expert for the National Electric Lamp Association, on "Electric Service Rates," an abstract is as follows:

ELECTRIC SERVICE RATES.

In opening the subject Mr. Merrill stated that central stations generally are beginning to realize that the rate question is no longer one of merely local importance, but that it has, in a sense, become a national issue in the industry. He further said that in discussing rates in a general way we must limit ourselves to considerations of the form in which the rates are made and in discussing the forms of rates we may classify the electric service rendered by a central station under two broad headings; first, small lighting service, and second, large lighting and power service.

The first class of service needs special attention because it applies to a relatively large number of customers. These customers are individually of small size, and gross return from their service may in many cases be but a small part of the total revenue of the station. They are unacquainted with cost analyses of any kind and it is not as easy to impress them with the importance of the overhead and fixed expense incurred in rendering service as in the case of the merchant or manufacturer who has to deal with somewhat similar problems in his own affairs. The elements in the cost of service can be explained more easily to the large customers, and since there is but little objection on their part to a rate covering the overhead expense and the running expense by separate charges, there is a general tendency toward the adoption of a graded two charge rate for such service.

The time interval over which the energy consumption is to be averaged in obtaining the maximum demand for large customers served on a two charge rate is usually either 15 or 30 minutes for general power and lighting service. The shorter the interval is made the heavier will be the penalty imposed upon fluctuating loads.

The form of rate which is meeting with very general approval for the small lighting customer carries two or three Kwhr. rates in the following general form, here again the actual values are inserted for illustration only. 12c. per Kwh. for first 30 hours use per month of maximum demand; 6c. per Kwh. for next 30 hours use per month of maximum demand; 3c. per Kwh. for all over 60 hours use per month of maximum demand. Minimum bill, $1.00. Discount for payment within limited period. In this form of rate, which is coming into fairly general use, a great diversity of opinion exists as to how the maximum demand should be determined as a basis for fixing the number of kilowatt hours to be used at each rate before the next lower one applies.

The most direct method would naturally be to measure the maximum demand of each individual customer, but there are several reasons why this cannot be undertaken at the present time. First, there is no demand meter or indicator on the market which is sufficiently cheap to allow it to be used on all installations. Second, due to the large diversity factor applying to the use of most heating and cooking devices, which to a very great extent do not come on the station peak, it is hardly proper to include them in the present measurement of demand. Some day, when the use of such apparatus has become much more general and when it has been developed to an extent which makes it a very important part of the small consumer's loads, then, if a cheap demand meter has been developed, it will find a wide field of application.

For the time being the central stations using the multiple rate for small lighting service, have adopted various methods of approximating the demand which determines the customer's responsibility for the station peak. Some stations arbitrarily assign a fixed wattage per socket, counting a certain percentage of the sockets in an installation. As an alternative to the method of counting each socket at a fixed wattage, other stations have attempted to calculate the actual wattage, installed from the ratings of the individual lamps. It is needless to say that this method, while not tending to limit the installation as in the previous case, presents many difficulties in practice. As a means of simplifying the problem and at the same time removing several serious objections to the methods of determining demand previously mentioned, the illuminated area of a dwelling has been made use of in several rate systems. The success with which this method has met in actual practice makes it worthy of serious consideration. Several methods have been developed, some use area directly while others use the number of rooms as a demand basis. As a rule the demand so determined is reduced to the equivalent hours use at the primary rate per room or per unit of floor area. Usually the estimated demand per room or per square foot, or what is equivalent, the number of Kwhrs. required at the primary rate for each room or unit of area, is made to decrease slightly as the size of the installation increases. The following will serve to illustrate the general form in which such rates appear. In this case the demand per room is not expressed directly in watts but is reduced to equivalent kilowatt hours use per month per room at the primary rate.

RESIDENCE LIGHTING SERVICE.

To customers contracting for service for one year or more, for residence lighting service, with free renewal of Company's standard lamps, the following rate shall be used:

A. Primary charge of 12 cents per kilowatt hour for:

(1) The first four (4) kilowatt hours consumed per month for each of the first four (4) active rooms;

(2) The first two and one-half (2½) kilowatt hours consumed per month for each of the active rooms in addition to the first four (4).

All rooms except the following shall be counted as active; 3 bedrooms, bathrooms, basement, garret, closets and back porch.

B. Secondary charge of 5 cents per kilowatt hour for all energy in excess of that paid for at the primary rate in (a) up to a total of 100 kilowatt hours and 4 cents per kilowatt hour for the next 900 kilowatt hours.

The central station in order to protect itself most completely should reserve the right to install a demand meter on any customer's service and use the maximum reading thereof as a basis for the future rating of the installation. With this end in view the rate made should preferably appear as follows:

SMALL LIGHTING SERVICE RATE.

12c. per Kwh. for first 30 hours use each month of maximum demand; 6c. per Kwh. for second 30 hours use each month of maximum demand; 3c. per Kwh. for all over 60 hours use each month of maximum demand.

The maximum demand referred to above shall be the maximum five minute demand recorded at any time and in no case shall it be less than 70 per cent. of the maximum instantaneous demand of the installation. The maximum demand when once determined shall be used in calculating all subsequent bills until a higher demand has been recorded, at which time such higher demand shall be taken as a new basis.

Minimum Primary Consumption residential. In residential service the minimum number of units required at the primary rate will be determined from the number of rooms as follows: Four (4) kilowatt hours per month for each of the first four (4) active rooms; Two and one-half (2½) kilowatt hours per month for each of the active rooms in addition to the first four (4). All rooms except the following shall be counted as active: 3 bedrooms, bathrooms, basement, garret, closets and back porch.

Minimum Primary Consumption Commercial. In commercial service the minimum number of units required at the primary rate shall be figured at not less than 5 Kwh. per 100 square ft. floor area for the first 500 square ft. and 2.5 Kwh. per 100 square ft. for all area in excess of 500. Ordinarily the minimum demand rating of the installation as determined above will be used in place of the measured demand. A minimum monthly bill of $1.00 shall be required.

The foregoing statement gives simply the essence of the scheme. If a station wished to, it could definitely establish a minimum wattage rating per room or per unit of floor area which, when multiplied by the number of hours use required per month would give the minimum number of Kwh. for the installation. The actual wording of the rate could be simpli-

fied in different ways so as to be clear to the ordinary consumer. This, however, is a matter for each individual to deal with according to his local conditions with which he is best familiar.

While undoubtedly this form of rate will be criticised by some for its apparently arbitrary assumption of the relation between illuminated area and peak responsibility, still it is not nearly as arbitrary as the rate assuming a fixed wattage per socket which has actually been made in many cases, neither is it subject to as much abuse as a method which endeavors to take into consideration the actual wattage connected. The rate expressed in this form has the advantage over a system using measured electrical demand as a basis in all installations in that it does not count in electrical devices of various kinds, which because of their day use and present large diversity factor should really bear but a small portion of the demand charge. The option reserved by the central station to install a demand meter in any case will protect it from devices which consume a very great deal of energy for very limited periods. Ordinarily this option would not need to be exercised by the station. Moreover this form of rate, with the demand estimated from some function of the premises which is easily measured and not subject to change, serves to make it possible for the central station to gradually reduce its minimum demand requirements in case the customers install lamps of lower and lower wattage.

When a station has any considerable amount of very small lighting business within easy access of its lines, it should by no means overlook entirely the possibilities that lie in the form of demand rate using a flat rate controller or current limiting device and no watt hour meter. Such a rate could be made to apply to installations of from 50 to 250 watts maximum demand, for which a flat rate of perhaps 1 cent per month per watt of contracted maximum demand could be made. The minimum demand that could be contracted for under this rate might be 50 watts. In certain localities a large number of purely lighting installations might be secured under some such simple rate. By limiting the rate to about 250 watts maximum demand no ordinary heating devices could be used. A customer wishing to avail himself of the convenience of such devices would naturally go on to the regular multiple rate. In one case, however, that I know of, a flat rate for electric irons is made to customers on a flat rate controller, the iron being connected in around the limiting device.

In concluding Mr. Merrill stated that the two charge rate carrying graded demand and energy charges is generally regarded as particularly well adapted for the large lighting and power customers. A multiple rate with primary, secondary and perhaps tertiary charges, based upon electrical demand with a minimum consumption at the primary rate fixed by the floor area or number of rooms, seems to offer many advantages for the ordinary small lighting customers. For the very small lighting customer the flat demand rate possesses many advantages and is certainly worthy of careful consideration.

The discussion on this paper was taken part in by T. J. Duffey, Natchez, Jno. S. Black, New Orleans, Professor Reid, P. Stern, New Orleans, W. H. Sparrow, Hattiesburg, W. F. Gorenflo, Gulfport, A. H. Jones, McComb, S. M. Jones, Laurel. This paper was one of the most interesting presented during the Convention, and the discussions developed the fact that much thought was being devoted to the subject.

T. J. Duffey thought it would be hard to explain a multiple rate system to customers. John S. Black cited his personal experience as satisfactory in New Orleans where the change has recently been made from straight Kw. hour charge to multiple rate.

W. F. Gorenflo thought the only excuse for the straight Kw. hour rate was its simplicity and doubted the success with any other, especially where many foreigners were customers.

Professor Reid cited a personal experience with a similar rate in which it worked out well.

S. M. Jones asked for a rate which would permit the use of electric cooking appliances on a lighting meter?

A. H. Jones suggested a rate of such flexibility that it would be adaptable to all conditions and pointed out that such a rate could be offered as an option to customers who complained or were dissatisfied with old rates. Gradually the new rate would attract attention and win favor and eventually permit the discontinuance of the old rate.

After this paper the meeting adjourned to Pearce's Dreamland where an illustrated paper on "Modern Street Car Construction for Small Cities," was presented by George L. Kippenberger and W. L. Alt, of St. Louis Car Company. This was a very elaborate paper and entered into considerable detail of design and construction, illustrations of types being shown. Discussions by A. J. Carter, Meredian, W. B. Moorman, Vicksburg; I. H. McArthur, Meredian, W. L. Alt, Geo. L. Kippenberger.

At the afternoon session called at two o'clock the nominating committee was elected to make nominations for the officers for coming year. After this the meeting adjourned and many members enjoyed an automobile ride through Vicksburg National Military Park and Cemetery. A ticket for this ride was furnished each member at time of registration, the tickets being provided by the Association. At this time Vice-President Claggett had the honor of entertaining Mr. Harold Almert, of Chicago, representing General Geo. H. Harries, as a party on the trip through the Park. At 6:30 the executive committee and their wives entertained Mr. Harold Almert at dinner at the Carroll Hotel. At 8:30 a public session was held at the Warren Street Theatre at which Mr. Almert delivered an address on "Public Relations," of which address the following abstract is given:

Mr. Almert's remarks were flavored with common sense and represent the most progressive ideas of the most successful central station organizations today. We quote from his address as follows:

"The service which public utilities furnish, the rates which they charge, and the manner in which they conduct their business, vitally interest the public in the community which they serve. The companies also are desirous of rendering the highest possible class of service, charging reasonable rates and conducting their business in an efficient and economical manner. Between the two, public on one hand and utilities on the other, there is a true community of interest; the relations between them, therefore, should be harmonious in every respect. In the past, however, this has not always been the case.

"Controversies have frequently arisen from mutual misapprehension of the demands and requirements of the respective parties, and the effect of such controversies, not being conducted in a spirit of fair play, and mutual respect, has worked untold hardships on public utility service. It has caused suspicion and ill will among the immediate beneficiaries and has had the effect of retarding progress and constructive development of public service enterprises in general. Both parties suffer largely from the strained relations existing under such circumstances. One of the causes of these controversies has been the franchises passed in the early days by municipalities and accepted by utilities, and as conditions changed, the public and the municipalities have sometimes failed to meet the companies in fairness and declined to sanction adjustments which every consideration of fairness and justness prompted, and in other cases the companies have been at fault and taken undue advantage of rights hastily granted to them and refused to accede to the reasonable requirements that the public founded on changed circumstances and conditions surrounding the business.

"In the end both parties desire the same conditions to prevail, I am sure; namely, a high grade of service, reasonable and compensatory rates and efficiency and economy in the operation of the service.

"In my judgment bitter controversies are wholly unnecessary. As a rule neither the public nor the companies intend to be unfair or unreasonable. The situation requires therefore that a means be devised to bring about and maintain an amicable and friendly understanding between the companies and the public.

"Every active public utility is composed of two principal parts: 'a plant' and a 'francihse.' The streets and the alleys which the public utility has to use belong to the public; the the public, therefore, has a right to say how and to what

extent they shall be used. The public contributes one of the prime essentials, namely, the franchise, the company provides the plant. As already stated, therefore, it follows that the company and the public are partners in the enterprise. On the other hand, they who invest the capital, time and energy, expect compensation measured in dollars and cents. On the other hand, the public expects good and adequate service at fair rates. The rights of one should be equal to the other, and the interest of one should not be furthered to the detriment of the other.

"I will list what I believe to be the principal obligations of both parties to a franchise: The obligations of the utility include the following: First: Rendering of good, adequate and continuous service. Second: Fair and reasonable rate schedules. Third: No discrimination among customers of the same class, or between classes of customers for like service. Fourth: Extension of service into all populated sections of the municipality and suburbs. Fifth: Earnest endeavor to market the greatest volume of service. Sixth: The adoption of approved inventions and developments in machinery and apparatus. Seventh: Sound financing and management. Eighth: A high standard of physical maintenance. Ninth: Public-spirited attitude in all matters concerning the general welfare and advancement of the community. Tenth: Broad and liberal business administration. Eleventh: Keeping faith with the people in all agreements, promises and announcements. Twelfth: Strict obedience to law and no participation in politics. So much for the public utilities duties and responsibilities as we comprehend them.

Granted that the utility corporation lives up to this code, what is due from the public?

"First: The same degree of confidence, encouragement and respect that one business man accords to another; that any citizen expects from his neighbor.

"Willingness to permit a fair profit on the capital, energy and ability and risks embodied in the undertaking to permit a profit greater than mere interest which could be obtained without effort or hazard.

"Third: Disregard of attacks by popularity-seeking agitators.

"Fourth: Willingness to recognize and reward improvement in service.

"Fifth: Recognition of the fact that the operation of utilities differs fundamentally from merchandising and manufacturing.

"Sixth: Reasonableness in demanding a large capital cutlay for improvements not strictly necessary to the rendering of adequate service, such as placing wires underground in cities of small and medium size.

"Seventh: To make prompt payment of bills, because the company cannot render the service demanded of it if its only source of income is retarded.

"Eighth: Protection against direct competition.

"Ninth: Careful consideration of legislation, municipal, state and national. This would hamper and curtail the development of utilities.

"Tenth: Recognition of the fact as starting from a given baseline which varies in different localities, reduction in rates can be procured without financial loss only by increasing of service sold.
sold.

"Eleventh: Recognition of the fact that no utility company can well serve a municipality if it is not in a prosperous condition and able to secure the investment of new capital on favorable terms.

"Twelfth: Treatment of all questions effecting public utilities in a fair-minded way, looking upon them as business questions without regard to political consideration.

"In conclusion I beg to state that where the conditions of franchise are reasonable, the management of a public utility is progressive and conducts its business as a public trust, the terms of its franchise matter little. On the other hand, if the management refuses to recognize the equity of the public and declines to be liberal and fair, that management will go down to merited defeat and financial loss, regardless of the most liberal franchise ever granted."

These remarks do not embody the idle dreams of a theorist but represent the working basis of the H. M. Byllesby organization, which Mr. Almert represents, as well as that of the founders and mainstays of the National Electric Light Association in whose behalf he speaks. This latter organization has no equal in the civilized world today either in numbers of members or in influence. Its field includes every section of the United States and its phenominal growth and active support by central stations from every part of it, speaks only too strongly of the evolution now taking place in the central station industry and the need for a clearing away of the differences that have arisen in the past due to local misunderstandings as to the nature and relation to the community, of the public utility.

This address was well received by the people of Vicksburg and a request was made by the Board of Trade for one hundred copies.

THURSDAY SESSIONS

On Thursday morning the session was called to order at 9:30 and a paper presented by J. C. Mahoney, Turbine Expert of General Electric Company. Mr. Mahoney explained that the author was unavoidably detained. An abstract of the paper follows:

MIXED AND LOW PRESSURE TURBINES UP TO AND INCLUDING 750 KW.

The low pressure turbine has shown itself admirably adapted to the utilization of steam expanding from 1 pound gauge or somewhat lower to 27 to 28 inches of vacuum. The physical dimensions of a low pressure turbine to handle a given quantity of steam are much less than those of a low pressure engine for the prime reason that the velocity at which the steam travels through the turbine is much greater than that of a reciprocating prime mover. For a given cylinder volume the amount of steam which can be passed through in a given length of time is limited by the most economical point of cut-off and the highest piston speed which can be used.

The turbine suffers from no limitation of this sort but passes the steam from one stage to the next at the spouting velocity of the steam due to its initial pressure in the nozzle throat in relation to the pressure in the succeeding stage, speaking of the impulse or Curtis type of turbine. It is borne out by experience that the best condensing reciprocating engine plants may have the economy improved approx. 25 per cent. and the peak load output increased 60 to 90 per cent. by the installation of low pressure turbine. A low pressure turbine and condenser will practically double the output of a non-condensing engine with no increased boiler capacity. The economy of installing low pressure turbines has been very thoroughly demonstrated in the past few years and there are a number of plants which have either greatly increased their economies by these installations or that have greatly increased their peak load capacity or both.

The mixed pressure turbine is one embodying as its name implies a combination of high and low pressure. In case of a deficiency of low pressure steam, it is desired to replace that deficiency by the economical use of high pressure steam taken into the turbine at boiler pressure. There may be also times when repairs may be made on the engine and the capacity of the turbine is badly needed. At such times it is run as a high pressure unit carrying full load at economies comparing favorably with those of a straight high pressure unit. A still further function of the high pressure feature is the bridging over of periods of no low pressure steam in plants where the supply of low pressure steam is intermittent. A good example of this service is steel mill works where the exhaust from blooming mill engines is utilized. In such installations there is a plentiful supply of steam for 30 seconds and for the next 30 seconds there will be no low pressure steam.

An additional advantage of the mixed pressure turbine over the low pressure turbine supplied with high pressure steam through a reducing valve is that the machine will carry a certain proportion of its load on high pressure steam non-condensing. It is undesirable, for many reasons, to design these machines so that they will carry their full load non-condensing but their ability to carry some load, should the condensing apparatus fail, would undoubtedly be of value in many considerations.

It does not seem desirable to install smaller units than 300 Kw. due to cost of piping, condensers, etc. Each case should, however, be considered on its own merits as local conditions, especially favorable, might make it desirable to install smaller sizes. There are a number of plants where the supply of condensing water is the stumbling block for low and mixed pressure turbines. There are undoubtedly a number of plants where the use of cooling towers or spray systems has been overlooked where water is scarce and which are annually losing large sums of money, due to their failure to realize the low cost of and excellent results to be obtained from artificial water cooling. No condensing proposition ought to be discarded without very careful analysis and that after securing the best

guarantees to be secured from condenser builders and manufacturers of spray systems.

A discussion was taken part in by W. F. Cox, Natchez, F. L. Bailey, Meredian, E. J. Lenz, Greenville, and W. F. Gorenflo, Gulfport, H. W. Young, Chicago, H. Almert, Chicago.

The next paper was presented by its author, Mr. W. F. Gorenflo, on "Coal, Hand and Mechanically Fired." An abstract follows:

COAL HAND AND MECHANICALLY FIRED.

For economical combustion of fuel a complete and thorough mixture of air and gases at high temperature and proper place must be had. It is therefore necessary to admit air over the surface of the fire to burn the gases and through the fire to burn the carbon. This requires that air be admitted both through the fire doors and through the grate bars, and is best controlled by a damper; but in nine cases out of ten you will find the fireman using the furnace doors. Oftentimes opens them wide to prevent smoke with the mistaken idea that by doing so he gets the best possible results, when all that he has done is admitted a great deal of air which cools the gases, getting the same economy that he would obtain by opening the coil chute into the ash bin.

Coal should be bought by its heat value as determined by the calorimeter, but a coal burned in a calorimeter showing a high B.t.u. does not always mean that it is the coal you should buy. I have seen coal of 11,100 B.t.u. evaporate more water than one of 12,600 B.t.u. This was entirely due to furnace construction, method of firing, and plant conditions. The low B.t.u. coal was more completely burned.

It matters not how you stoke your boiler, whether by hand or mechanically, your furnace must be fitted to the kind of coal you expect to use; the fuel must be spread evenly and fed regularly; and of such depth, governed by the size of the coal principally, that it will admit the proper amount of air through it. There should be no bare or thin spots on the grate surface, nor should coal be too thick. Look into the furnace of any hand fired boiler and you will find the following methods used; an evenly fired surface; a wedge shaped surface, thick at the back and thin at the front, or just the reverse; a hollowed surface, thin in the middle and thick at the sides; or a heaped surface, thick in the middle and thin at the sides. The first two methods are good, but the last two are very bad.

The recognized requirements are a uniform and continuous supply of fuel to the furnace; an air supply slightly in excess of the theoretical amount required for complete combustion; a temperature sufficiently high to ignite the gases that are driven off from the fuel; and a complete mixture of these gases with the air supplied before they reach the boiler shell or tubes. In other words it means that you must have complete control over your method of firing, and this cannot be done until we get some device that is entirely automatic. The human element should be entirely eliminated. The average fireman believes that all he has to do is to industriously feed the furnace with coal. There are numerous automatic stokers on the market that aim to comply with above conditions, but none yet built does much more than feed the coal regularly and evenly without the admission of air through the furnace doors. This goes a long way toward the economical consumption of coal.

In a plant using a small amount of coal where it is necessary to have but one fireman on duty it is questionable whether or not it would be good practice to install mechanical stokers, but where two or more firemen are required it would be well for the operator to investigate the merits of a stoker which will burn slack coal and decrease the expense of getting it into the furnace. The greatest wastes that takes place in our plants are the losses in the boiler furnace.

This paper was very interesting and the discussion was entered into by H. Almert, Chicago, H. W. Young, Chicago, W. F. Cox, Natchez, F. L. Bailey, Meridian, W. B. Moorman, Vicksburg.

At the executive session held at 3 o'clock, reports of committees were received. That on President's address and Secretary's report recommended committees be appointed to consider the following: Public Utility Commission Laws; Public Policy and Insurance; Line Construction and Grounding Secondaries; Meter Testing and Practice; Electric Heating and Cooking

The committee on resolution brought a report extending the thanks of the Association to the City of Vicksburg, Vicksburg Light and Power Co., President Gilchrist, Secretary T. C. Martin of National Electric Light Association, and Mr. H. M. Byllesby, for attendance of Mr. Harold Almert at Convention. To Elks for courtesies and daily press.

The following officers and members of Executive committee were elected: R. B. Claggett, president; W. F. Gorenflo, vice-president; A. H. Jones, secretary and treasurer. Members of executive committee were elected as follows: F. J. Duffey, Natchez; A. B. Paterson, Meredian; S. M. Jones, Laurel; W. B. Moorman, Vicksburg; A. H. Jones, McComb.

Invitations for the next Convention were received from Hattiesburg, Natchez and Jackson, and the decision as to choice of meeting place will be made at the executive committee meeting, the first of the year.

ENTERTAINMENT FEATURES

The entertainment features of the convention were particularly well cared for and the arrangements worked out

Group of Convention Delegates at Vicksburg.

to the delight of all members and guests. On Tuesday evening a reception to members and guests was held at which a spirit of getting acquainted prevailed. The trip through the National Military Park and Cemetery of Vicksburg in automobiles at the expense of the association has been mentioned and was a feature to be remembered by all. On Thursday evening a banquet was given to members and guests at which one hundred were present and during which many spirited remarks were made by a selected list of speakers. The association and especially those responsible

R. B. CLAGGETT, PRESIDENT MISSISSIPPI ELECTRIC ASSOCIATION.

for the management of affairs at this the Vicksburg convention have made such a favorable impression on all attending that the event will ever bring to their minds days of profit and pleasure.

The Sons of Jove held forth on Wednesday evening and under the able direction of Statesman Cable, fourteen candidates were initiated and banqueted with over 50 Jovians in attendance.

W. F. GORENFLO, VICE-PRESIDENT MISSISSIPPI ELECTRIC ASSOCIATION.

Mr. R. B. Claggett who succeeds Jack Abbott as president of the Mississippi Electric Association is entirely familiar with the work to be done in view of the fact that he served last year as vice-president and during the latter part of the year as acting president. He is a central station man of considerable experience and thoroughly familiar with the situation in Mississippi so that the work to be accomplished by the association during the coming months will proceed along the same well directed lines.

THE NEW PRESIDENT.

Mr. Claggett is a graduate of the Virginia Military Institute in 1904, and did special work in civil engineering at the University of Illinois in 1905. He came South in 1906 and took up his present work with the Delta Electric Light, Power and Mfg. Co., of Greenville, of which company he is secretary and treasurer. He is a member of the Sigma Chi fraternity, University of Illinois; Kappa Kappa chapter, also a member of the Masonic order. In 1907 he married Miss Belle Barkley, of Greenville and has one child. In Greenville he is associated with Mr. Henry Crittenden who is an association member and convention delegate whom all remember in a most cordial way.

Los Angeles Aqueduct Hydro-Electric Project.

The city of Los Angleles has recently approved a bond issue amounting to $357,567 to complete the equipment of the hydro-electric project to be operated in connection with the 250-mile aqueduct by which the city water is brought from Owens Lake near the Yosmeite National park. The generating equipment will be installed at Power House No. 1 located at San Franciscedo, 47 miles from Los Angeles to which point current is sent at 60,000 volts. In the power house there will be installed three 9375-kva., 6600-volt, 50-cycle, three-phase water wheel generators running at 200 r. p. m.; and two 250-kw., 250-volt direct-current water wheel generators used as exciters; ten 3150-kva., single-phase, 50-cycle oil insulated water cooled transformers for raising the generator voltage (6600) to that of the transmission, 60,000. In the substation there will be installed nine 5000-kva. single-phase, oil insulated water cooled transformers for stepping down the transmission voltage to either 33,000 or 16,000 for secondary distribution.

An Electrical Meterman's Handbook.

The National Electric Light Association's committee on meters has prepared an electrical meterman's handbook. This book should be of greatest interest and value to all company and individual members who are interested in the measurement and sale of electricity, as it will contain practically all authoritative information required by any one in charge of the operation of electric meters, from the standpoint of the executive, the installation, or the testing department, and for the guidance of Civic Commissions. It has been compiled with strict adherence to the viewpoint that there was an urgent need for authoritative action toward the establishment and elucidation of standard modern electric meter practice, and the compilation of available data in one place for ready and convenient use of the testers and metermen of the thousands of companies whose technical abilities are more or less limited, as well as those of larger companies whose organization is more complete. The price of the book to members is $2.00, to non-members $3.00. It contains 900 pages, 4 x 6 and bound in flexible cloth.

First Convention of Gas, Electric and Street Railway Association of Okla.

The first annual convention of the Gas, Electric and Street Railway Association of Oklahoma was held at the Lee-Huckins Hotel, Oklahoma City, May 22 and 23, 1912. The convention was formally opened on the morning of May 22 by President N. R. Gascho when he introduced Hon. J. W. Johnson, representing Mayor Whit M. Grant of Oklahoma City, who addressed the convention and welcomed its members to the city. This address of welcome was followed by an able response by President Gascho. In a most interesting way he reviewed the growth of the section and the position public utilities have taken in this upbuilding and growth. He further reviewed the struggles of the smaller companies in Oklahoma referring to his company, The Alva Light & Power Co., and the conditions which obtained in his section. He voiced the fact that if the public utility company carries on its business open and above board in a public spirited way in the community it will get a square deal and urged that the association be developed along this plane and made such that no public utility can afford not to be a member.

President Gascho spoke at some length on regulation by commission, stating that it is a new feature in Oklahoma and that he favored it, remarking that in place of being a hinderance to an electrical community, it has advantages. He urged that the central stations approach their tasks with a spirit of fairness and have some reliable source of information by which the corporation commission can find out the true state of affairs in connection with public utility enterprises, thereby enabling them to make wise and just recommendations regarding necessary laws to be enacted.

The first paper of the morning session was presented by F. E. Bowman, manager of Ada Electric & Gas Co., Ada, Okla., on the subject "The Central Station Manager as a Public Servant." He mentioned the fact that the association membership included both municipal plants and those owned by corporations and individuals, stating that all were working toward the same end, serving the public in one of the necessities of business and home life. He carried on a logical argument in regard to looking after the customer's interest, giving advice in regard to installation and in general consulting with customers in such a way that they will be in every way satisfied.

The discussion of Mr. Bowman's paper was taken part in by the following: F. H. Tidnam, vice-persident Oklahoma Gas & Electric Co.; R. C. Leonard, new business manager Oklahoma Gas & Electric Co. G. W. Knox, Oklahoma Railway; Thomas Gray, manager, Norman Milling & Grain Co.; V. R. Francis, manager Kingsfisher Municipal Plant; J. A. Freeman, manager Hobart Electric Co.; and Lincoln Beerbower, manager Enid Electric & Gas Co. The discussion took up in a very interesting way an analysis of the causes for complains and "kicks" by customers. It was generally agreed that the central station business should be discussed more among outside people and the details advertised in such a way that people could understand those points in which they are most interested. Instances were brought up where this has been done and matters were successfully solved. It was pointed out by Mr. Pritchett that troubles usually arises from the fact that people making complaints are ignorant along the line complained of and usually refer to poor lights and high bills. President Gascho suggested that the customers be encouraged to read their meters and explain in those cases where the parties are interested, the method used in caring for and testing meters. Others discussing the matter were L. A. Pritchett, of Marlo Municipal Electric Light Plant; A. V. Hancock, Oklahoma City manager of General Electric Co., of Texas; J. C. Chalfant, Superintendent Light and Water Property of Claremore.

The next paper of the morning session was presented by E. J. Mackey of the Westinghouse Electric & Mfg. Co., on the subject, "The Relation of the Central Station to their Customers Through the Medium of the Electric Meter." In this paper the different features of the various types of watt-hour meters were outlined giving in some detail the effects of varying loads, frequency, and power factor, as well as making adjustments and caring for the meter.

The discussion of this paper was entered into by Messrs. L. Beerbower, V. H. Francis, F. J. Meyer, E. J. Mackey, president Gascho, S. W. Barnes, H. V. Bozell, C. S. Dawley and F. H. Tidnam. The principal part of the discussion was in regard to location of meters on open porches or in enclosed cabinets. It was learned that meters had been installed on porches, in cabinet boxes and on poles with varying success, and on account of the fact, F. H. Tidnam suggested that the matter be looked into and urged that steps might be taken to adopt the best method in the state of Oklahoma. This discussion closed the morning meeting.

At the afternoon session on Wednesday, Prof. R. E. Chandler, Dean of Engineering of the Oklahoma A. & M. College, at Stillwater, read a paper on, "Crude Oil as a Fuel in Place of Coal." This paper brought out many interesting figures obtained from tests made at the Oklahoma Agricultural and Mechanical College to determine the comparative cost of burning coal and crude oil under the boilers at the college heating and power plant. The average evaporation determined from tests on several different kinds of coal was about six and five tenths pounds of water per pound of coal. With coal costing $4.00 per ton delivered at the bin, the cost of evaporating a pound of water was .0307 cents. The tests to determine the amount of water evaporated per pound of oil showed that about 14.2 pounds of water was evaporated per pound of oil. The oil cost 83 cents per barrel on the siding, making the cost of evaporating one pound of water from oil fuel .02 cents. This showed a saving over the use of coal of about 35 per cent, which would amount to a saving of from two to three thousand dollars a year for the college. Prof. Chandler also mentioned that a further saving was effected in labor cost. The paper took up in detail the tests made on coal giving results in form of tables. The same details were given in regard to tests with crude oil and the conclusions arranged in tabulated results.

The discussion of Prof. Chandler's paper was entered

into by Messrs. Chalfant, Francis, Tidnam, Dawley, Johnson, Beerbower, Knox, and Molinard. The discussion was mainly along the line of burning coal and oil, the various speakers giving experiences covering different features.

The next paper was presented by C. W. Day, master mechanic of the Oklahoma Railway Co., of Oklahoma City, on the subject "Necessity for Standardization of Equipment." Mr. Day in his paper took up particular examples where standardization was desirable pointing out how the standardization could be made. He showed how by making repair parts interchangeable, the store room requirements would be reduced to a minimum and the operation of properties carried on in an economical way. The discussion of this paper was taken part in Messrs. H. V. Bozell, F. J. Mayer, W. F. Barnes, D. R. Detwiler, N. R. Gascho. The discussion referred to the standardization of the Street Railway and Interurban Association on trucks and the opinion was general that car equipment could at least be brought down to three or four general standards. It was brought out that there is a wide variance in meter and transformer construction and lighting voltages which also could be standardized.

The next paper on the program was delivered by Paul M. Galloway, manager of the Tulsa Corporation on the subject of "Gas Engines." Mr. Galloway was not able to attend the convention and his paper was read by C. G. Walker of his company. The author spoke very favorably of the gas engine and believed that it offered a solution to the problem of generating power at the lowest possible cost. He described in some detail the Rathburn Gas engine operated by his company. He stated that the results obtained in actual operation on the system owing to variations in gas meters, pressure regulators, temperatures, etc., are variable but seldom exceed a consumption of 13 cubic feet per Hp. per hour.

Discussion was taken up by L. A. Pritchett, and C. S. Daley, Mr. Pritchett outlined the installation of an 80 Hp. oil engine which took up the work given up by a steam station on account of not being able to make the plant pay and immediately enabled the company to place the plant on a paying operation. Solar oil costing $3.35 per barrel was used. A 22 hour service is maintained and the fuel cost at this rate is from $90.00 to $106.00 per month. Mr. Daley brought out the point that gas engine operation is satisfactory but not as reliable as the steam engine, having a greater upkeep efficiency. This discussion closed the work of Wednesday afternoon.

On Wednesday evening the members were addressed by Hon. J. E. Love, chairman of the State corporation Commission of Oklahoma, Mr. Love took up in some detail the jurisdiction of the commission, referring to gas and electric utilities. He commented upon the fact that while there are in Oklahoma only 33 cities above 3000 population, there were in 1911 in the state 113 corporations engaged in the light, heat, power and gas business. Through the physical valuations of all these properties by the commission, there is shown an aggregate value of over $13,000,000 based on the figures furnished by the companies. He commented upon the immense task that has fallen upon the shoulders of the central stations in trying to serve the public in the cities of Oklahoma which have shown, between the dates of 1900 and 1910, such remarkable increases in population as in some cases to reach as high a figure as 400 per cent increase. He further stated that in the cities of Oklahoma City, Muskogee, Tulsa, Enid, McAlister, Shawnee, Guthrie, Chicksha, Ardmore, Sapulpa, El Reno. Lawton, Bartlesville, Durant, and Hugo, consumers of electric current for all purposes paid last year $1,210,611.38 for 19,648,241 Kw. hours. The lowest maximum rate in any of these fifteen cities is 8 cents per Kw. for the first 200. The highest rate is 20 cents per Kw. for all used for domestic purposes. The average maximum domestic rate is 13 cents per Kw., the rate in Oklahoma City is 11 cents, which as in the case of the gas rate is below the figure allowed by the company's franchise. He commented upon the wide variation in rates throughout the state and stated that an electric rate schedule should be gone into very carefully and emphasized the need for the adoption of the uniform plan for constructing the rate. He urged further that co-operation be given and emphasized the fact that the corporation commission desired to see the fair thing done.

Following Mr. Love's address ,talks were given by Messrs Tidnam, and Classen. Mr. Tidnam gave a short account of his visit to England and Continental Europe, mentioning the many differences he found there and in American, particularly in the matter of accounting. Mr. Classen referred to the Corporation Commission and the work it is doing, also spoke of the benefits to be obtained through the association.

At the opening of the Thursday morning session, May 23, E. B. Johnson, of the Oklahoma Gas & Electric Co., gave a short talk explaining a map of Oklahoma state that he had prepared on which were shown the various towns in the state having municipally operated public utilities He also showed those towns having privately owned public utilities, showing whether gas, electric light, or street railway, or all, also the population served and the capital invested in the state as well as the total Kw. capacities of the electrical properties.

The next subject on the program was a paper delivered by C. E. Lahman, manager of the Vinita Ice Light & Power Co., on the subject of "The Operation and Efficiency of Tungsten Lamps." The author recommended that for street lighting purposes the 250 watt tungsten lamp is better adapted than the 425 watt arc lamp, mainly on account of the greater glare of the arc lamp. He referred to the use of tungsten lamps on his system and gave considerable data as to maintenance.

The discussion brought out that the fact that in the town of Vinita, $350.00 per month had been paid for arc lamps while with the use of incandescents, the price had been lowered to $265.00, the cost of making the change was about $5.00 per arc lamp installed at that time.

The next order of business was the presentation of a paper by V. H. Francis, Supt. of the Municipal Water & Light Plant of King Fisher, on the subject of "Why the Municipal Plant is not, As a Rule,, and How It Could Be Made A Success." The reason for the lack of success was attributed to the fact that the direct responsibility for failure of profitable operation does not rest upon one person and no one person interested in the plant is materially effected financially, whether the plant is a success or is not a success. It was the opinion of the author that a successful municipal plant can only result by placing the plant in direct charge of one man paid an efficient salary and given a percentage of the profit. In this way he will minimize

expenses and run the plant as economically as possible to increase his profit.

The discussion brought out the opinion that the rules governing the reporting, accounting systems and general rules for municipal plants should be the same as for privately owned property. This would prevent juggling accounts by taking money away from water departments and putting into electric accounts or the reverse and the plant made to show whether there is really a gain or a loss. It was pointed out that the public service commissions of New York and Wisconsin have the authority to require the same report from the municipally owned plant as a privately owned on.

The afternoon session of Thursday was opened by a paper delivered by H. H. Stephens, manager of the El Reno Gas & Electric Co., on the subject of economical operation of small central stations. Mr. Stephens for the purpose of his remarks confined the small station to one serving a population of less than 8000 and having a maximum capacity of 1000 Hp. The first essential for securing economy in the operation of the central station he named was co-operation and loyalty of the working force. He stated that the ordinary small station wasted from 15 to 20 percent of its fuel by careless firing, air leaks around boilers, and through boiler settings, etc. Summing up, he stated that economy in operation of the small station can be largely effected by attention to little details of saving, repairs and improvements that can be noted by the fireman, the engineer, the superintendent, the office force and the manager.

According to the report of Secretary and Treasurer, H. B. Bozell, State University, Norman, the efforts of the organization have been largely directed toward increasing the membership and toward this end there has been remarkable success. In October 1911 there were eight Class A members, five Class B members and three associate members. At the time of reading the report, there was 40 Class A members, 30 Class B members, and 20 associate members.

The officers elected for the coming year are the following; F. W. Caldwell, manager Shawnee Gas & Electric Co.; F. E. Bowman, manager of the Ada Electric & Gas Co. vice-president; H. V. Bozell, director of the School of Electrical Engineering State University, secretary and treasurer; Messrs J. A. Freeman, manager Hobart Electric Co.; C. S. Dawley, manager Okmulgee Ice & Light Co., directors.

The entertainment features in connection with the first annual convention of the association of Oklahoma were especially provided for and successfully worked out. These features included a smoker at Belle Isle and a most elaborate and enjoyable banquet at the Lee-Huckins Hotel on the last night of the convention at which many interesting addresses were given by the leading spirits of the association and the public service corporations throughout the state. It may be said that the first convention was a decided success, first in membership at the meetings, and second in amount of work done during the four busy sessions. There were in attendance over 90 representatives of the 125 concerns doing business in the electric, gas, and street railway fields of the state which indeed speaks well for the first convention of any organization of these interests.

Convention of Arkansas Association of Public Utility Operators.

The central station men making up the membership of the Arkansas Association of Public Utility Operators held their fifth annual convention at the Marion Hotel, Little Rock, Ark., May 20, 21, 22. At the time this convention was in session, the convention of the Oklahoma Gas, Electric and Street Railway Association was underway, beginning on the 22, and continuing until the 23. At the close of the latter convention the fourth annual meeting of the Mississippi Electrical Association took place at Vicksburg, on May 28th, 29th, and 30th. Three neighboring states thus held conventions during the ten days beginning May 21st and ending May 30th.

The convention was opened by the address of President J. M. Hewitt, of Mariana. The first paper on the program was read by W. H. Walkup, of Batesville, on the subject of, "Troubles and Their Remedies." Mr. Walkup took up the operation of medium and small size plants mentioning improvements in engine and boiler room so as to cut down possible waste. The discussion took up the experiences of the different members and brought out many interesting facts in connection with troubles with a generating plant.

The next paper was presented by Prof. W. N. Gladson, of the University of Arkansas, on the subject of, "Uses of Electricity." Prof. Gladson reviewed briefly the progress in the application of electricity, commenting upon the various fields in which it has entered and predicting its increased use in many ways in the future.

The discussions which followed this paper took up different subjects mainly of interest along new business lines and promoting the use of electricity. B. C. Fowels, of Pine Bluff, was of the opinion that it is good policy for the central station to sell lamps at cost, thereby keeping control of lamps, for he argued that supply dealers have no motive to persuade customers to buy large size lamps and customers fill their sockets with smaller lamps than they would in many cases. Mr. Patterson of Fort Smith touched upon motor service, stating that his company installs motors on trial and if satisfactory they are paid for on 30, 60 or 90 days payment. He was opposed to renting motors. The subject of house wiring campaigns was taken up and in every case those who had tried them out believed that they were of great benefit to the station.

The Tuesday morning session was opened by a paper on metering and the equipment of central station laboratories by T. A. McDowell of the Westinghouse Electric & Mfg. Co. In this paper he took up the particular features of direct and alternating current watt-hour meters and the primary and secondary standards for checking meters. He gave considerable information on testing meters and advised

that tests on alternating current meters should be performed not longer than two years apart.

The second paper was prepared by E. C. Bellamy, of Mammouth Springs, on "Water Power in Arkansas" but was read by the secretary on account of the fact that Mr. Bellamy was unable to be present. This paper took up the hydro-electric development of Mammouth Springs and discussed at some length the possible water sites in the state of Arkansas. It was mentioned that the hydro-electric development described was the first to erect in connection with its power stations, a steel tower transmission line, which transmission line is 36 miles long.

The next paper of the session was read by V. A. Hain on the establishment of day service. This paper was prepared by H. J. Mauger of the General Electric Company and considered plants in cities of less than 5000. It was stated that 1000 electric irons placed in circuit on any system will bring in enough revenue to pay for the establishing of the day service when if fans, small motors and heating devices are added this will be profit. It was also advanced that it is possible to increase the revenue by day load from $3.00 to $5.00 per capita per annum to $10.00 to $15.00.

The next paper was read by A. E. Smith, of Little Rock on the subject of "Sales and Use of Electrical Heating Appliances." The author of the paper agitated placing these devices on trial allowing them to be paid for on the installment plan. He agitated the maintaining of a complete line of devices in an exhibit room and that all solicitors should have first hand information and complete data so that they could talk to customers in dollars and cents instead of watts when discussing the use of current consuming devices. Mr. McClendon, of Fayetteville, mentioned the success of a woman solicitor for his company who placed 482 irons among 780 customers on their system. A novel idea was mentioned by Mr. Hewitt of Mariana namely that his company gave as a wedding present to each newly married couple some electrically heated device.

A very interesting paper on unity power factor motors as related to single phase versus polyphase distribution was read by F. N. Jewett of the Wagner Electric & Mfg. Co., of St. Louis.

The final paper of the Wednesday session was read by M. Q. Woodard of Pine Bluff on the subject of "Ornamental Street Lighting." The author described the system installed at Pine Bluff consisting of 122 posts made of iron pipe and each post carrying four 60-watt tungsten lamps in 16-inch opal globes. This system was described and illustrated in the December issue of SOUTHERN ELECTRICIAN. It was mentioned that the monthly payments during the first year cover the cost of poles and energy at approximately 75 cents per Kw. hour. After this period only the amount to cover cost of energy is collected.

At the executive session which followed the reading of Mr. Woodward's paper the officers for the coming year were nominated and elected as follows: J. W. McClendon, of Fayetteville, president; W. C. Maguire of Arkadelphia, first vice-president; J. F. Christy, of Jonesboro, second vice-president; A. E. Main, of Hot Springs, third vice-president; W. J. Thorpe, of Little Rock, secretary and treasurer.

August Convention of Georgia Section of N. E. L. A.

At the mid-year executive committee meeting of the Georgia section of the National Electric Light Association, held at Athens, Ga., in April, it was decided to hold the annual convention this year, at Tybee Island, August 15, 16, and 17. Arrangements are now well under way for this convention. Mr. W. R. Collier, president of the section and general contract agent for the Georgia Railway & Power Co., of Atlanta, advises that he has appointed the necessary number of committees to take care of the program, the entertainment features, and other matters connected with the convention and that these committees already have their work well in hand and are very optimistic in regard to the plans which have been formulated.

Mr. J. S. Bleecker, manager of the Columbus Railroad Co., is chairman of the program committee and Mr. M. L. Sperry, manager of the Savannah Electric Co., is chairman of the entertainment committee. Mr. Bleecker was the 1911 president of the section and with him in charge of the program this year is assurance of a most interesting one. In regard to it, he advises that the following papers have been arranged for. It is to be understood that the following subjects are, however tentative and that there may be changes and additions.

"The Present Status of The Electrical Vehicle in the Southeastern States," by A. N. Bentley, manager of the Atlanta office of The Electric Storage Battery Co.; "A Mechanical Collector, its Offenses and Defenses," by T. W. Peters, contract agent of the Columbus Railroad Co.; "Synchronous Condensers and the Correction of Power Factor," by H. E. Bussey, resident engineer of the General Electric Co.; "Buying Coal on a B. T. U. Basis," by M. L. Sperry, manager of the Savannah Electric Co.; "Electric Rates," by G. S. Merrill, asst. chief engineer of the National Electric Lamp Association: "Diversity Factory,' by W. L. Southwell, commercial engineer of the Central Georgia Power Co.

Further an article, the title of which has not yet been decided upon, will be presented by an engineering representative of the Westinghouse Electric & Mfg. Co., and a report of the public policy committee, touching on the relative advantages and disadvantages of long and short term franchises will be given by P. S. Arkwright, chairman of the Public Policy Committee. Mr. Bleecker also advises as follows: "There will doubtless be a representative present at the convention from Knoxville, to explain the plans of the National Conservation Congress now planning to have an exposition in Nashville in 1913.

"The order in which the papers will be presented as mentioned above has not been decided upon, nor do I know exactly how the final program for the convention will be arranged at this time as this would naturally be decided by President Collier after getting reports from all the various committees, but I understand that the convention will probably open for registration and general "get together" on the morning of the 15, and that there will be two or three business sessions and general entertainment sessions extending through the 15, 16, and part of the 17.

Details as to final arrangements and the final program will be published in the August issue, which will reach readers sometime before going to the convention.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Last Month's Discussion.

The question of public policy, as taken up in our June number, was pertinently discussed by the commercial representatives of two central stations. These discussions do not close with one issue and we hope that others will follow with their comments or views. The opinions presented coincide with our editorial views, that is, that cordial relations with the public is not only desirable, but possible, and may be brought about by the exercise of sound ethical and business principles, and that as central station managers come to realize the identity of their interests with those of the community they serve, the cry of "soulless corporation" will not be simply smothered, but effectually silenced, because it will no longer be true.

While the opening discussion did not include a particular mention of rates, yet both contributors seem to feel that rates are a vital element in moulding public opinion. It seems quite fitting therefore that in this number we should consider the question of rates and service. Next month we plan to take up in a general way, the functions of a well organized commercial department, and follow this by a detailed study of its make up.

The Influence of Rates and Service on the Extension of Business.

Leaving the general question of public relations, we will now consider in detail some of the most important factors in stimulating a demand for electric service. The effort put forth to secure new business may vary all the way from the negative influence of a company having a dingy little office on a back street, where the public have to come and almost plead to be connected, up to that of a wide awake concern having an aggressive and adequate soliciting force continually raking their territory for the last Kw. The principal factors affecting the demand for electricity, may be said to be the character of the service and the rates charged. This is entirely analagous to the business of any other manufacturer or merchant who has merchandise to sell. He finds that the demand for his lines depends, except as affected by location, upon the quality of his goods, the prices he asks for them, and the service he can give through store clerks and delivery.

Under the definition of central station service, is included the steadiness of the voltage, the continuity of the current, and the quality of the lamps furnished, if free renewals are given. Other details may be mentioned such as pormpt connections, prompt attention to complaints, and such other attentions as are a part of the regular service given. As a rule the commercial manager has nothing to do with these, but if he realizes their effect upon the efficiency of his department he will co-operate in every way he can to make such conditions real and thus improve the service. He may do this by referring at once, all unfavorable comments about the service which may come to the attention of himself or his solicitors, to the operating department for attention. Furthermore he can see that the customer is given satisfaction, and made to feel that the company is not only willing but anxious to keep its standard of service at the highest point. If he is a technical man, he can often by analyzing the complaints that come in, be able to make valuable suggestions as to how the causes may be eliminated. In many cases the right sort of advice of a technical nature at the time of complaint, will give the customer more satisfaction than a reference to a trouble department with a delay of a day or so and a final careful analysis of the situation. The new business or commercial manager should be an electrical engineer of no little experience. Further, if his department and the operating department have the proper spirit of co-operation, there should not be the least friction over adjustments of any kind. However, since the point of view is usually different in these two cases there will generally be some points open to dispute, and here is the time for the general manager to take a hand and preserve strictly harmonious relations.

The matter of rates comes strictly under the jurisdiction of the commercial manager, not the primary or base rate, as that depends upon the cost of production, but the adaptation of the rate to different classes of service, the details of contracts, guarantees deposits, service charges, and other conditions which while not strictly classed with rates, may yet be considered in the same connection. We do not intend to go into a technical rate discussion ,but simply to consider the relation of rates to business getting.

Naturally the demand for electric service, other things being equal, will be stimulated by a low rate. Therefore economic generation and distribution, since they allow of a lower selling price, are prime factors in developing business. These are in the main controlled by local conditions, such as the cost of fuel, labor, etc., and the nature and condition of the physical properties, and often by financial consideration. An experienced commercial man, who is familiar with the conditions in a good many different localities may sometimes be able to give advice that may result in a reduction of current costs.

The great interest at present evinced in rates may be judged from the considerable number of queries and answers bearing on the subject in the monthly bulletin of the N. E. L. A. It may be remarked that few, if any of the questioners seem to be interested in the theory of rates, but all address their inquiries from a commercial standpoint, that is they desire to know how to adapt rates to attract certain classes of business. For instance some of the most numerous questions have had to do with guarantees and deposits, and other details of contracts for ordinary domestic and commercial business, also with rates for street lighting, both arc and incandescents, multiple and series, lighting of large office buildings and apartments, signs, windows, use of flaming arcs for display, large power jobs, combination power and lighting, welders, refrigeration, cooking, high voltage motors, special residence rates, such as the two rate and three rate system, and the controlled flat rate, also in regard to the best ways of putting through change of rates, etc.

Each of these questioners, and there were several in-

terested in each of the above mentioned topics, had come across some condition requiring some modification of the base rate to meet that condition. It is manifestly impossible to go into detail as regards each of these, first on account of the space required, and secondly, while we might consider that we had settled the matter in these columns, there would always be plenty of exceptions. There are however some basic principles which we may give. First, we need scarcely say that the rate must be adequate. Second, it must not be manifestly unjust or discriminative, especially it should not discriminate in favor of the large consumer. Of course we all know, and it is easily proved, that the large customer, or the long burner can be served at less cost per Kw. than those of opposite characteristics, and we are not arguing for the making of equal rates. We do feel however that to sell a large consumer current below cost and make it up on the smaller ones, is a rank injustice, and bound to react unfavorably. It is better to accomodate the small customer with an attractive and popular rate, and make up the deficiency, if there is one, by a very small increase in revenue from the large consumers.

All central station men are or should be familiar by this time, with the Doherty and the Hopkinson rates, which take into account the fixed and variable charges connected with the service. Mr. Wood in his discussion in this issue reviews these rates thoroughly and we remark here that while it is very true that these factors must be taken into account, yet it does not follow that these rates in their usual forms will prove in themselves, attractive business getters. In fact the evidence would seem to be to the contrary and the final problem seems to be, how to make a rate adequate, equitable and yet popular.

With a view to offering our opinion toward the solution of this problem, we will comment on the different service and for this purpose divide all central station business into five classes. First, residence and small stores for light or light and power mixed. Second, small motors, especially those which can be put on regular lighting circuits. Third, all medium and large commercial and industrial work, light, power and other uses. Fourth, street, window and sign lighting. Fifth, special, such as non-peak, and breakdown service and flat rate service on very small loads.

1. The best solution for the first class seems to be a popular meter rate, with nominal guarantee. Any attempt to introduce an element of fixed charges seems to have a tendency to kill this class of business, unless made optional. There may be a loss in supplying some residences at the popular rate, but they must be secured and go to balance a fair average. Another recent and very popular rate for small residences is the controlled flat rate. It has its ardent advocates and its determined opposers. To enter into the arguments for and against would not be in place here, so that we will confine ourselves to what has come within our experience, namely, that it is a great business getter for small residences, and among a class of people who otherwise would not use current at all.

2. Small power, from say ½ to 2 horsepower can best be taken on a meter rate, lower than that for lighting, assuming longer hours of use. This is not scientific but for small installations it will answer sufficienly well, and avoid the expense of additional instruments to record the demand, and the additional accounting necessary.

3. Large consumers of all kinds should be taken on the basis of demand and consumption, either on the Wright system of successively lower prices for successive amounts of current, or on the basis of fixed charge plus a charge per Kwhr. consumed carefully explained by Mr. Wood in these pages. There is no need of making any discrimination between light and power as this system should be able to take care of anything from a fair sized store to the largest industrial establishment. If the central station receives a certain return per Kw. of demand, and an adequate rate per Kwhr. consumed, it makes absolutely no difference what use is made of the current.

4. Street, window and sign lighting comprise a class of business with hours of burning that can be definitely fixed and can be taken on a flat rate. There is a great attraction about a flat rate to most people, besides a flat rate on this class of business stimulates long hour burning, and thus improves the appearance of the business districts and is a good advertisement for the use of electric light generally. The rate can be easily computed from the known demand and burning hours.

5. Strictly off-peak service has, properly speaking, no demand and can be profitably taken at a reasonable profit above the variable current cost, as no overhead charges have to be made up on it. In regard to break down service, there exists a wide difference of opinion. Scientific treatment is hardly in place here. We believe in a very liberal breakdown policy, that is not to burden the customer with large standby charges. There is really no necessity for doing so, because the diversity factor is very large. This does not apply, however in the case of a customer who runs his own plant by day and takes central station at night. In this case his rate should be figured on the basis of demand and consumption, as explained under the third heading.

Ordinarily this disposes of everything that the commercial manager may meet. There is however, an exception in the case of electric irons for domestic use or a very small motor such as might be used in a dentists or physicians office or similar cases. In these cases, a flat rate is probably better than a meter. The flat rate for ironing is attractive and sufficiently accurate to meet all ordinary domestic work, while the flat rate on the small motors not only saves the expense of a meter, but will generally bring in a greater revenue than a meter would, besides saving the cost of meter reading, and accounting.

To sum up then, our recommendations are:

1. A popular meter rate for small lighting installations.
2. A popular meter rate for small power installations.
3. A controlled flat rate (optional) to be pushed hard among the small residences.
4. A "scientific" rate (optional) to get the big business.
5. A flat rate for lighting during definite hours.
6. A no-demand rate for off-peak service (A special case of No. 4.)
7. A liberal break-down meter rate, with not too high a demand factor. (This may also be considered a special form of No. 4.)
8. A flat rate for domestic irons, very small motors, porch lights, and other work not justifying the investment in a meter.

Finally, the whole scale should be kept as flexible and as optional as possible. If advisable to change rates, do not force the new rate on customers. The natural increase

of business, with advantage taken of changes, etc., will soon result in the bulk of the business being on the new rate. Keep away from excessive deposits or guarantees, they discourage business and serve no useful purpose. Service charges are also discouraging, and are also not strictly equitable where one party has to pay them and a subsequent user gets the benefit gratis. It is better to let them come under overhead expenses.

The above suggestions we offer as representative of the consensus of opinion from many sources. We make no claim to finality, and hope that any of our readers will feel free to criticise any of the above statements as much as they may wish. We are particularly desirous of examples from the actual practice of rates which have been successful and good business getters.

A. G. RAKESTRAW.

SUGGESTIONS FROM READERS.

Franklin P. Wood, Engineer New Business Dept., Arkansas Valley Railway, Light and Power Co., Cripple Colo., On Rates and Rate Making.

In the progressive development of all central stations, the rate question sooner or later comes to the front as an exceedingly active subject for diverting the mind of the management from ordinary routine business. Unquestionably the adoption of proper rates establishes a power company's prospects for a successful career. When one is tempted to criticise rates that have been made in the past, it is well to stop for a time and consider that ours is a comparatively new business, consequently we have not the wisdom and knowledge that is the heritage of those engaged in other lines of work. Then too, conditions are changing so rapidly in the way of large aggregations of capital, controlling extensive net works and systems and dominating the entire industry, that it is not strange that rates present a puzzling problem. Nevertheless there is only one way to go about it and that is scientifically.

Too often rates are established by the cut and try method with little idea of the real elements that should be taken into consideration. This discussion is an attempt to reduce the problem to its fundamentals and establish a basis on which logical and equitable rates can be made. Rates that have been made may be classified under the following heads: 1. The uniform meter rate. 2. Uniform meter rate with fixed discounts according to the amount used. 3. Two Meter rate. 4. Doherty rate. 5. Wright demanded system. 6 Hopkinson System. 7. Flat rates. 8. Various combinations and modifications of the above.

Discussing these various systems briefly it may be noted that:

1. The uniform rate method has little to commend it except extreme simplicity. An attempt will be made later on in this paper to show that there is little logic in charging a customer who uses the demand bx hours per day as much as one who uses the demand x hours per day.

2. Fixed discount rates are subject to the similar objection that the load factor is not considered and very often leads to an absurd condition by which a customer may use a little more energy and have his bill less.

3. Two meter rates make necessary the use of two meters, these multiplying the investment and the meter troubles of all kinds. It is more or less illogical, except in special cases, because we are rapidly approaching the condition in which there is no fixed time of day for the peak load to occur. It is also based on an unfair reasoning, which means that a customer is charged a high rate when the cost of manufacture is low and a low rate when the cost is high.

4. The Doherty system is composed of three elements: A. A service charge based on the cost of serving each customer. B. A charge based on the maximum demand as estimated on the number of lamps. C. An energy charge of so much per kilowatt hour. This is really logical and is a modification of the Hopkinson system, but lacks its simplicity. It is open to the objection that it is somewhat complicated and moreover the service charge can very logically be eliminated, since the service cost of supplying various customers does not vary largely and can very consistently be proportioned between the fixed charge and the energy charge of the Hopkinson system.

5. The Wright demand system charges a certain amount for energy used up to an amount which corresponds to the continuous use of the load for a short period, and a lower rate for all in excess of that. It is open to the objection that a special high priced demand meter is required and is really a deviation or modification of the Hopkinson system.

6. The Hopkinson system is really the most logical system devised. It divides the cost of current into the factors of which it is really composed and makes a charge on each customer proportionate to the demand and use.

7. A flat rate is not to be recommended very largely, except in cases where the demand is controlled and the hours use are absolutely known. Where such conditions exist flat rates can be made that are equitable and useful in securing new business. The rate tends to waste, however, and often causes dissatisfaction on account of the appearance of discrimination.

8. Under this classification comes numerous rates that are modifications and combinations of the above general classifications. Some fairly good and some with little to commend. Such rates are often made with some faint idea that they are what they should be. They are often forced by competition and are never scientific.

Assuming now that the Hopkinson method is the most logical, an attempt will be made to develope the subject along that line. As a simple proposition, it is obvious that central stations exist because of the need of the community for electrical energy and it is served better through the medium o fthe central station than in any other way. This need existing, if only in a potential form, is equivalent to the realization of capital being forthcoming to supply that need. In order, however, that capital may be employed, it must be shown that it is or will be profitable and that the original investment may be secure and returnable in a definite time. Aside from capital investment the other elements entering into the cost of production of electricity is the amount of raw material and labor actually consumed in its manufacture.

Therefore, in making rates, or, in other words, selling prices, we have two general factors to consider, which indeed must be considered in any business enterprise. They are: capital invested. Manufacturing costs aside from interest and other fixed charges.

The first thing then is to determine how much is invested in the plant under consideration. In order to have a definite basis on which to estimate fixed charges it is customary to take the cost of the system at so much per kilo watt of capacity. Since it is never possible to utilize the

full capacity of a plant, because to insure uninterrupted service it is necessary to keep a certain portion of the plant in reserve, it is good engineering, as well as good business, to divide the total cost of the system, not by the total capacity, but by that portion of the capacity that good engineering judgment indicates as safe to sell.

The investment per kilowatt being determined, the next thing to know is what interest is to be paid on the investment, how long a period can be taken in which to establish the sinking fund for the return of the original investment; and what taxes, insurance and other fixed charges should be. This can all be reduced to a percentage of the investment. These points being fixed the actual manufacturing costs should be determined, and these must be determined for each individual plant and should be taken at so much per kilowatt hour. The whole matter would be greatly simplified if a company having, say X kilowatts of available capacity, could sell X Kilowatts. As a matter of fact it is almost impossible to tell what can be sold. Again good judgment must enter into the calculations. Available market, proper rates, energetic and competent management are all important factors in determining what can be sold, but since it is impossible to tell absolutely what the market will stand a higher rate than obtainable under perfect conditions is justifiable.

In order to put the matter into concrete form a specific example will be assumed. Let this be a central station supplying a combined power and lighting load and operating 24 hours per day. It is also assumed that this central station will have two general conditions to meet:

First: Supplying customers within the city limits and requiring secondary distribution (as separate from the primary distribution), transformers in small units, meters, etc.

Second: Supplying customers in large blocks outside the city limits and requiring only one set of transformers for reducing the pressure from that of the transmission to that which is used.

Since the investment in the latter case is much less than in the former, and moreover since the load factor will probably be better and the general expense less, power can be sold for less than in the first case.

The first case will be discussed mainly as this applies to the condition of a majority of the central stations. The assumed rated capacity will be 3000 Kw., the available capacity 2000 Kw. Cost, including generating station, transmission lines, transformers, distributing lines, meters, etc., $500,000. Therefore, cost per kilowatt of available capacity is $500,000.00 divided by 2000 or $250.00. This investment cost should include all construction, engineering, superintendence, promotion expense ,sale of bonds, interest on money during construction up to the time the system becomes productive, and, in fact, every direct and indirect expense.

Assume further that the market is available for the full 2000 kilowatts and that the resulting load factor of the system will be 25 per cent. (Load factor being based on 2000 Kw. and on 730 hours per month.) Fixed charges 15 per cent on the investment. Cost of manufacture of current delivered to customer, (this taking care of all line and transformer losses) one cent per kilowatt hour.

The basis on which to make the rate is thus divided into the two general classes:

1. The 15 per cent of $250.00 is $37.50 per year, or $3.12 per month per kilowatt. It might be well to introduce here the diversity factor. This is the ratio between the sum of the maximum of the various loads to the actual maximum demand. For instance, a diversity factor of two means that one kilowatt of generator capacity will care for two kilowatts of consuming devices as distributed among various customers. If the diversity factor could be absolutely known the charge as given above could be reduced. Such a procedure, however, might result in lowering the price to such an extent that the increased use of the demand would bring the diversity factor to unity and thus endanger the capacity of the plant. It would be more safe and equitable to assume a diversity factor of one and make the fixed charges as reasonable as possible. This would mean that the customer would pay for the peak as if it came at the time of the station peak, in fact the station could have no off peak business.

2. Add 50 per cent to the manufacturing costs for profit, thus making the variable charge one and a half cents per kilowatt hour. As the load factor increases the manufactory cost per Kw. hour will go lower which is also a very valuable consideration in making rates that will build up load factors.

Therefore, a perfectly equitable rate would be $3.12 per kilowatt of demand, plus 1½ cents per kilowatt hour, or some rate that would be equivalent to that in its results. The writer believes a rate in that very form would be perfectly feasible to put into effect with lighting customers. The exact mode of determining the demand is a question to be settled.

The rate research committee of the N. E. L. A. last year recommended that the fairest and easiest way was to base this on the surface of the rooms illuminated. Other suggestions are that the sockets, or the lamps used, or a portion of them, be taken as a basis. But, the writer, in common with others believes that a simple, reliable and inexpensive demand limitator to be used in connection with the regular meter can and will be developed.

TABEL I. SHOWING RESULTS FROM APPLICATION OF RATE, $3.12 PER KW. PER MONTH DEMAND PLUS 1½ CENTS PER KWH.

Hours Use Per Day.	K. W. Hrs. Per Mo.	Energy Charge	Fixed Charge	Total Bill	Cents Per K. W. Hr.	Dollar Per K. W. Y.
1	30.4	.456	3.12	3.57	11.4	42.84
2	60.8	.912	3.12	4.03	6.6	48.36
3	91.2	1.36	3.12	4.48	4.9	53.76
4	121.6	1.82	3.12	4.94	4.0	59.28
5	152.	2.28	3.12	5.40	3.55	64.80
6	182	2.73	3.12	5.85	3.21	70.20
7	212	3.19	3.12	6.31	2.97	75.72
8	243	3.64	3.12	6.76	2.8	81.12
9	273	4.10	3.12	7.22	2.65	86.64
10	304	4.56	3.12	7.68	2.52	92.16
11	334	5.01	3.12	8.13	2.43	97.56
12	364	5.46	3.12	8.58	2.36	102.96
24	729.6	10.94	3.12	14.06	1.92	168.72

Such an instrument would practically be a circuit breaker that would open the circuit when the load exceeded the demand for which the customer has contracted. It would take care of the demand, not only of lamps, but of heating and other current consuming devices as well. The effect of the use of such a combination of demand limitator and meter, and the establishment of a rate consisting of a fixed charge, plus a low energy charge, would be for a customer to keep his demand as low as possible and increase his energy consumption.

Table No. 1 is designed to show various things resulting

from the application of such a rate to a one kilowatt installation. The bill per month for any other sized installation is found by multiplying the bill as given in the table by the size of the installation express as kilowatts. For instance, a customer having a demand of 600 watts and using that demand the equivalent of two hours per day, would have a bill of $4.03 times .6 or $2.41 and an equivalent rate per kilowatt hour of 6.6 cents. For six hours use he would have an equivalent rate of 3.21 cents per kilowatt hour, etc. Now the tendency of this rate would be that a residence customer for instance could use all sorts of consuming devices, such as irons, vacuum cleaners, hot plates, small heaters, and so on, providing the maximum demand did not exceed the amount for which the limitator was set and if it did exceed this demand the instrument would operate immediately and notify the customer of the excess.

Since lighting load factors seldom exceed one to two hours per day, it will be noticed by the table that a normal lighting customer would pay about the same amount per kilowatt hour that he would pay with ordinary rates. As his load factor increases, either by the longer hours use of lamps, or by the use of other consuming devices, the rate will and should automatically drop. To say that the rate per kilowatt hour in any given plant is, for instance, 15 cents does not necessarily mean that it is a high rate; neither does a 5 cent rate necessarily indicate a low meter rate. Load factors—hours use of the demand—must be taken into consideration.

In the early days of the business, when lighting for domestic and commercial use was practically the limit of the use of current, a high rate per kilowatt hour was perfectly justifiable. Since the adoption of the use of lighting to signs, windows and other advertising mediums, and the rapid progress made in applying electricity to cooking, heating and domestic work requiring small motors, it behooves central stations to make such equitable rates as will justify the most extensive use of current for all purposes.

A system of rates such as suggested above will accomplish to a considerable extent the desired result. Peak loads in the past, and largely at present, have been at the time of the lighting peak and therefore created a condition, by which, at other times of the day the central station was without much load and therefore able to dispose of power at a considerable reduced rate on "off peak schedules." This condition is rapidly changing, due to the increased use of energy for other purposes beside lighting, and it is difficult to determine at what time of the day the peak will come. This is a desired condition, since the nearer we can come to 100 per cent load factor the better will be our business. The point is, however, that "off peak" business will tend more or less to diminish and therefore the charge for all customers should be on the basis of the demand for power, as if this demand came at the time of the central station peak.

In its practical results this form of charging would work out as follows: Suppose a small lighting installation, of 300 watts maximum demand. This would permit the simultaneous use of twelve, twenty-five watt lamps, sufficient for the illumination of a fair sized house. Suppose the customer used the load on on average of one hour per day, he would use nine kilowatt hours and his bill would be:

Fixed .3 × 3.125 or	.9375
Energy 9 Kwh. × 1½ cts............	.135
	1.0725

which would be equivalent to nearly 11.4 cents per kilowatt hour. Suppose he used the load two hours per day: The bill then would be:

Fixed .3 × 3.125	.9375
18 Kwh. × 1½ cts	.27
	1.2075

or about 6.6 cents per kilowatt hour.

For commercial loads such as windows, store, sign, saloon and drug store lighting, the method would be equally advantageous. It would care for almost every conceivable condition in an equitable manner. Such a rate would enable central stations to successfully combat gasoline lighting installations that are impossible to touch with ordinary rates. It should be noted however that in any event a minimum, which should be rather high, should be adopted.

The bill and result per kilowatt hour can be quickly compiled for any hours use from the table referred to by simply multiplying the bill as given in the table by the demand expressed as kilowatts. Such a method of charging

TABLE II. RESULTING COSTS PER KWH. AT VARIOUS INSTALLATION RATES PER KW. AND AT VARIOUS LOAD FACTORS. ASSUMPTIONS: FIXED CHARGES TAKEN AT 10 PER CENT PER YEAR ON THE INVESTMENT. MANUFACTURING COST $.005 PER KWH. AT 50 PER CENT LOAD FACTOR.

Cost Per K. W. Installed in Dollars	Fixed Charges Per Month Per K. W.	LOAD FACTORS														
		5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
25	.208	.0109	.0079	.0068	.0064	.0061	.0059	.0058	.0057	.0056	.0055	.0054	.0053	.0053	.0053	.0052
50	.416	.0167	.0108	.0088	.0078	.0068	.0069	.0066	.0064	.0062	.0061	.0059	.0058	.0056	.0056	.0055
75	.625	.0225	.0137	.0107	.0092	.0084	.0078	.0074	.0071	.0069	.0067	.0064	.0062	.0060	.0059	.0058
100	.832	.0283	.0166	.0126	.0106	.0096	.0088	.0082	.0078	.0075	.0072	.0069	.0066	.0063	.0062	.0061
125	1.04	.0341	.0195	.0145	.0120	.0107	.0098	.0091	.0086	.0082	.0078	.0078	.0070	.0067	.0066	.0064
150	1.25	.0399	.0224	.0159	.0134	.0119	.0107	.0099	.0093	.0088	.0084	.0078	.0074	.0070	.0069	.0066
175	1.45	.0457	.0253	.0183	.0148	.0130	.0117	.0107	.0100	.0094	.0089	.0083	.0076	.0073	.0072	.0069
200	1.66	.0515	.0282	.0202	.0162	.0142	.0126	.0115	.0107	.0101	.0095	.0088	.0082	.0077	.0075	.0072
225	1.87	.0573	.0311	.0221	.0176	.0153	.0136	.0123	.0114	.0107	.0101	.0093	.0086	.0080	.0079	.0075
250	2.08	.0631	.0340	.0240	.0190	.0165	.0146	.0132	.0122	.0114	.0107	.0098	.0091	.0084	.0082	.0078
275	2.28	.0689	.0369	.0260	.0240	.0176	.0155	.0140	.0129	.0120	.0112	.0102	.0095	.0089	.0085	.0080
300	2.50	.0747	.0399	.0280	.0218	.0188	.0165	.0148	.0136	.0126	.0118	.0107	.0099	.0090	.0088	.0083

[Table No. 2 was prepared for ready reference in determining the cost of power for the central station. Example: What is the cost of power produced by a plant whose investment is $200.00 per kilowatt and the manufacturing cost one cent per kilowatt hour, at a 45 per cent load factor with fixed charges of 16 per cent on the investment? From the table the cost at 10 per cent fixed charge and .5 cents per kilowatt hour is .0101 minus .005 manufacturing cost equals .0051 or fixed cost. Since 16 per cent is 60 per cent more than 10 per cent, add 60 per cent to the above fixed charge, .0030 plus .0051, equals .0081. Add new manufacturing cost equals .01. Total, .0181. That is the cost per kilowatt hour under the conditions assumed is 1.81 cents per kilowatt hour. Knowing the investment, fixed charges and manufacturing costs of any station, it

is a simple matter to determine costs at any load factor by a few calculations based on this table.]

would also entirely eliminate all trouble resulting from longer hours use in winter over summer. An increase of several hours use on account of the low kilowatt hour charge would make but a small difference in the bill. People would learn to burn all night house and porch lights; would tend more and more to use toasters, coffee percolaters, irons, fans and small household motors.

Now, although the rate might go extremely low, as based on the kilowatt hour results, the result would still be desirable from the central station standpoint. For instance 1.92 cents per kilowatt hour for 24 hours use is much better than 11.4 cents for 1 hours use. Hence, the desirability of a rate that will bring about such a result.

siderable number of hours per day. The load factor of any installation is difficult, if not impossible to obtain when basing the rate on a flat charge per kilowatt hour and very naturally is constantly changing. Therefore, it is impossible to make a fair or equitable single meter rate per kilowatt hour.

The method advocated above (that is a fixed charge per kilowatt hour, plus a low rate per kilowatt hour) automatically cares for the load factor. The objection may be made that although the rate per kilowatt hour is low, the high charge that a customer would be obliged to pay in order to carry any heating load, such as an iron, would deter many customers from contracting for enough demand to carry anything but a normal lighting load. This might be true to

TABLE III. RESULTING PRICES PER KWH. AT VARIOUS RATES. (FIXED CHARGE PLUS A KWH. CHARGE) AND AT VARIOUS HOURS USE PER DAY OF THE LOAD.

RATES.

Per K. W.	$2.00	$2.00	$2.00	$2.00	$2.50	$2.50	$2.00	$2.50	$3.00	$3.00	$3.00	$3.00	$3.50	$3.50	$3.50	$3.50	$4.00	$4.00	$4.00	$4.00
Per K. W. H.	1c.	2c.	3c.	4c.	1c.	2c.	3c.	4c.	1c.	2c.	3c.	4c.	1c.	2c.	3c.	4c.	1c.	2c.	3c.	4c.
Hrs. use Per Day. 1	.0750	.0850	.0950	.1050	.0914	.1014	.1114	.1214	.1078	.1178	.1278	.1378	.1242	.1342	.1442	.1542	.1406	.1506	.1606	.1706
2	.0420	.0520	.0620	.0720	.0502	.0602	.0702	.0802	.0584	.0684	.0784	.0884	.0666	.0766	.0866	.0966	.0748	.0848	.0948	.1048
3	.0320	.0420	.0520	.0620	.0374	.0474	.0574	.0674	.0428	.0528	.0628	.0728	.0482	.0582	.0682	.0782	.0536	.0636	.0736	.0836
4	.0260	.0360	.0460	.0560	.0301	.0401	.0501	.0601	.0342	.0442	.0542	.0642	.0383	.0483	.0583	.0683	.0424	.0524	.0624	.0724
5	.023	.0330	.0430	.0530	.0262	.0362	.0462	.0562	.0294	.0394	.0494	.0594	.0326	.0426	.0526	.0626	.0358	.0458	.0558	.0668
6	.0210	.0321	.0421	.0521	.0237	.0337	.0437	.0537	.0264	.0364	.0464	.0564	.0281	.0381	.0481	.0581	.0291	.0391	.0491	.0591
7	.0190	.0290	.0390	.0490	.0213	.0313	.0413	.0513	.0236	.0336	.0436	.0536	.0259	.0359	.0459	.0549	.0282	.0382	.0482	.0582
8	.0180	.0280	.0380	.0484	.0200	.0300	.0400	.0500	.0220	.0320	.0420	.0520	.0240	.0340	.0440	.0540	.0260	.0360	.0460	.0560
9	.0170	.0270	.0370	.0470	.0188	.0288	.0388	.0488	.0206	.0306	.0406	.0506	.0224	.0324	.0424	.0524	.0242	.0342	.0424	.0524
10	.0165	.0265	.0365	.0465	.0181	.0281	.0381	.0481	.0197	.0297	.0397	.0497	.0213	.0313	.0413	.0513	.0229	.0329	.0429	.0529
11	.0160	.0260	.0360	.0460	.0175	.0275	.0375	.0475	.0190	.0290	.0390	.0490	.0205	.0305	.0405	.0505	.0220	.0320	.0420	.0520
12	.0155	.0255	.0355	.0455	.0168	.0268	.0368	.0468	.0181	.0281	.0381	.0481	.0194	.0294	.0394	.0494	.0207	.0307	.0407	.0507
13	.0150	.0250	.0350	.0450	.0162	.0260	.0360	.0460	.0174	.0274	.0374	.0474	.0186	.0286	.0386	.0486	.0198	.0298	.0398	.0498
14	.0147	.0247	.0347	.0447	.0158	.0258	.0358	.0458	.0169	.0269	.0369	.0469	.0180	.0280	.0380	.0480	.0191	.0291	.0391	.0491
15	.0144	.0244	.0344	.0444	.0154	.0254	.0354	.0454	.0164	.0264	.0364	.0464	.0174	.0274	.0374	.0474	.0184	.0284	.0384	.0484
16	.0140	.0240	.0340	.0440	.0150	.0250	.0350	.0450	.0160	.0260	.0360	.0460	.0170	.0270	.0370	.0470	.0180	.0280	.0380	.0480
17	.0138	.0238	.0338	.0448	.0147	.0247	.0347	.0447	.0156	.0256	.0356	.0456	.0165	.0265	.0365	.0465	.0174	.0274	.0374	.0474
18	.0136	.0246	.0346	.0446	.0145	.0245	.0345	.0445	.0154	.0254	.0354	.0454	.0163	.0263	.0363	.0463	.0172	.0272	.0372	.0472
19	.0134	.0234	.0334	.0434	.0142	.0242	.0342	.0442	.0150	.0250	.0350	.0450	.0158	.0258	.0358	.0458	.0166	.0266	.0366	.0466
20	.0132	.0232	.0332	.0432	.0140	.0240	.0340	.0440	.0148	.0248	.0348	.0448	.0156	.0256	.0356	.0456	.0164	.0264	.0364	.0464
21	.0130	.0230	.0330	.0430	.0137	.0237	.0337	.0437	.0144	.0244	.0344	.0444	.0151	.0251	.0351	.0451	.0158	.0258	.0358	.0458
22	.0129	.0229	.0329	.0429	.0136	.0236	.0336	.0436	.0143	.0243	.0343	.0443	.0150	.0250	.0350	.0450	.0157	.0257	.0357	.0457
23	.0128	.0228	.0328	.0428	.0135	.0235	.0335	.0435	.0142	.0242	.0342	.0442	.0149	.0249	.0349	.0449	.0156	.0256	.0356	.0456
24	.0127	.0227	.0327	.0427	.0133	.0233	.0333	.0433	.0139	.0239	.0339	.0439	.0145	.0245	.0345	.0445	.0151	.0251	.0351	.0451

Table 3, is designed to show resulting rates per Kw. hour for various hours use per day at various fixed charges per Kw. of demand and rates per Kw. hour. For instance a rate of $3 per month per Kw plus 3 cents per Kw. hour would result. for 2 hours use per day of the demand, in 7.84 cents per Kw. hour.

The report of the N. E. L. A. rate Committee in last year's proceedings is a very valuable analysis of existing conditions and will be worth the serious study of all central station men. It shows for one thing that although there is a diversity of rates and methods, the results are suprisingly similar. In this reprot the Committee makes a valuable point in its plea for a uniform method of charging, applicable to all central stations, and recommends a method the fundimental idea of which is substantially as above.

The general question is "Can an electric power company sell current for fifteen or ten or three cents per kilowatt hour?" This question is too general to be of much benefit when answered either in the affirmative or in the negative. Each company must take its own conditions into consideration. What must be known is, as noted in the first part of this article, the investment, with which must be known the desired return, and the material and labor costs of current per kilowatt hour. Then if a fixed price per kilowatt hour is to be made, the load factor at which the current is to be used should be known. If the price is made which will cover the low load factor customers, it will be discriminating against the customer who uses his connected load a con-

some extent, but it is to be expected that a large amount of educational work must be done. People can be made to see the extreme advantage of this method of charging and rapidly be induced to fall into line. It might be advisable for a time at least to maintain a straight meter rate in addition to the other form of rate as an alternative. This should be large enough to care for the low load factor installations. It is usually advisable to have more than one rate of which customers can take their choice.

In the opinion of the writer, the time is coming when all public service corporations will be under public service commission regulations. When this time comes the demand for rates that are equally applicable to lighting and heating will be so great that some form of rates will have to be adopted to care for this condition. The above advocated rate will fulfill all requirements and it is easily understood and demonstrated.

Rates that will get business are desirable and the high rates of the past have obstructed much progress in the development of all sorts of consuming devices. If one hundred per cent. load factor were obtainable, a controlled flat rate could be easily adopted. Progress along this line has been made in recent years in the development of heat storage devices, which are on the line all of the time, but even at the best such service will have a limited application. One device that gave promise of success was put on the market a few years ago, but apparently did not work out well in practice. The idea was that current when not used for

other purposes would be stored up in a heavy mass of iron or metal, by virtue of coils imbedded in the iron mass. Water coils were also imbedded in this mass and the water heated and used through the stored heat of the mass. The use of the device would permit the sale of energy on a flat rate schedule at one hundred per cent. load factor. Such is also the idea of some recent continuously connected load devices.

There is nothing really special in rate making for the sale of electricity any more than there is in fixing selling prices for any commodity or service. It should be based on sound principles. What we want to do is to sell all the current we can and make a fair profit and interest on the investment. The profit must be large enough to attract capital and not too large to endanger the rights of the public. To make the best of the business we strive for a high load factor. "Hitch your wagon to a star" is a good motto. Its application to the business of making and selling electricity is to strive for a one hundred per cent load factor. Even if it is not obtainable, its near approximation is worthy of most strenuous efforts. The public in general is ready and willing to buy and use all sorts of electrical devices, if the use thereof does not increase the bill out of proportion to the benefits received.

In making rates for the sale of power in large blocks one should follow the same general reasoning. However, it is generally the case that the investment per kilowatt and all day losses are very much less than in the case of ordinary distribution. In the future lighting revenue will be but a fraction of the total revenue of the plant. Proper rates will be one of the very potent causes of increasing revenues from all sources. High efficiency, low wattage lamps will soon cease to be the bugaboo of central stations, because revenue of equal and greater value will come from other consuming devices.

The time for radical action in regard to rates has come and when the whole question is brought down to its last analysis it will be realized that methods that are used in making selling prices for any other merchandise are applicable to marketing current.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

OBTAINING KW. FROM WATT METER READINGS.

Editor Southern Electrician:

(305) We have a G. E. standard polyphase testing instrument for 600 volt, 60 cycle circuit, and may be used on two-phase or three-phase circuits. The scale reads in hectowatts and the formula I use for reducing the reading to Kw. is as follows: For a reading of 18 hectowatts, $18 \times 100 = 1800$ watts, then $(1800 \times .64)/2 = 576$ Kw. This reading was taken with the current coils connected in multiple and the voltage reduced from 600 to 300 by a multiplier.

What I desire to know is, why is the 1800 multiplied by .64 and divided by 2? What is the factor .64? Are there other formula for obtaining Kw. from reading of such an instrument?

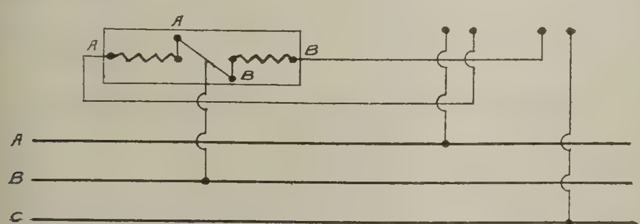


DIAGRAM OF MULTIPLIER CONNECTIONS.

The multiplier has four terminals as shown in the sketch. Is the arrangement shown the proper method of connecting in the resistances? There is a constant of 2 uses with these multiplier connections. I would appreciate information on these points from readers. W. R. K.

CALCULATIONS FOR TRANSMISSION LINE.

Editor Southern Electrician:

(306) Kindly publish the following questions in the question and answer columns of your paper. (1) We have $10\frac{1}{4}$ miles of transmission line, three-phase, 60 cycle, the first four miles being No. 4 B. & S. hard drawn copper wire spaced 40 inches between centers. The latter $6\frac{1}{4}$ miles is No. 1 hard drawn copper wire spaced 30 inches centres. Give formulas and compute the inductance, reactance, capacity, drop, impedance, etc., and power factor, of each section, that is the first four miles and the latter $6\frac{1}{4}$ miles, for transmitting 1000 Hp. at 10000 volts at receiving end.

What will be the power factor, inductance, impedance, etc., of an additional 15 miles of No. 3 aluminum strand cable spaced 30 inches centers to transmit 500 Hp. at 10000 volts, 60 cycles? What will be the drop, inductance, impedance, power factor, etc., of the full length of line ($25\frac{1}{4}$) miles maintaining 10000 volts at $10\frac{1}{4}$ miles from the generating station?

(2) If the power factor drops below 80 per cent on the above line would it be advisable to install a synchronous motor to raise the power factor, if so, what size of motor would be required, to raise the power factor to 90 per cent or 95 per cent? Which would be most satisfactory, a synchronous motor carrying a mechanical load or a synchronous condenser floating on the line? There are considerable fluctuations on the system due to mine hoists, and it is quite common to get 60 per cent peaks for a couple of minutes and the frequency will sometimes drop four cycles. It will vary as much the other way when the load drops off. The voltage of the system is maintained by a Tirrill regulator. Would synchronous apparatus work satisfactory under these conditions? We have two generators, one 600 Kw. the other 450 Kw., both 10,000 volts, 60 cycles, 3 phase.

(3) Kindly draw a curve to the following wattmeter readings:

Standard Kw. 280, 352, 352, 342.4, 352, 229.6, 352, 256, 352, 371.2, 281.6, 348.8, 352, 217.6, 348.8, 352, 300.8, 256.

Graphic in Kw. 287, 363, 370, 345, 345, 225, 345, 260, 345, 374, 260, 340, 350, 240, 345, 360, 310, 245.

There are here 18 readings, each reading of the graphic corresponds to a reading of the standard in the order that they appear. Plot to numbers of reading as base and value in Kw. as ordinate, both curves on one sheet and explain.

W. R. KING.

GROUNDING SECONDARIES.

Editor Southern Electrician:

(307) Is the grounding of secondaries any additional protection to apparatus or entirely a protection to life? For what particular reasons has the Underwriters made grounding of secondaries compulsory? G. S. R.

SINGLE VS THREE-PHASE TRANSFORMERS.

Editor Southern Electrician:

(308) What are the conditions necessary to decide between the use of 3-phase as against single phase transformers? What are the arguments, in regard to costs, flexibility, and failure for each? Why is it that 25 cycle transformers cost more than 60 cycle for same rating?

W. S. M.

OPEN DELTA VS OTHER CONNECTIONS.

Editor Southern Electrician:

(309) Kindly advise the particular advantages of the open delta connection for transformers as far as economy goes. I ask this question because I happen to know of a system where the open delta seems to be the standard connection or at least was at one time the standard connection. Compared with, star, T or delta where does the economy or lack of it come in and why should the connection be generally used on any system? W. T. B.

PROPER METER CONNECTIONS.

Editor Southern Electrician:

(310) Kindly straighten out my trouble as to wattmeter reading and connections. I have a 5 ampere watt meter with its field coils connected in series on 2300 volts primary and its armature connected on secondary of a one Kw. transformer with 110 volts secondary. On the meter dial is written $1 \times 10 \times 20$, what is the constant and how many Kw. according to the following readings, April 999,000 and March 800,000. On compound generators should volt meter be connected across plus and minus leads or across equalizer and minus and why? K. W. HILL.

Size of Motor for Pumps, Ans. Ques. No. 277.

Editor Southern Electrician:

I have noticed two answers in the May issue to question 277 in regard to type of motor for operating pumps. These answers cover this point very well but do not give the inquirer the formula requested for arriving at the proper size. On this account I offer the following information and will assume a case to illustrate the method used. Suppose it is desired to know what Hp. of motor is required to operate a pump with 10 inch cylinder and 14 inch stroke, to be run at 100 Rpm. against a head of 100 feet.

The volume of water passing through the pump per minute is equal to the volume of the cylinder during forward and return strokes in cubic feet times the Rpm. Thus, $[78.5 \text{ (area cyl.)} \times 2 \times 14 \times 100]/1728 = 220$ cubic feet of water per minute.

The work done by the pump and required by the motor must represent the horsepower required to lift this amount of water 100 feet per minute. Thus this quantity of water in pounds times 100 feet will be the foot. lbs of work done per minute, and this quantity divided by 33,000, the number of foot pounds per minute representing a horsepower, gives the work done expressed in Hp. Thus, with 62.5 lbs. the weight of a cubic foot of water we have: $[220 \times 62.5 + 100]/33000 = 41.6$ Hp.

This is the horsepower required should it be possible to get apparatus to work at 100 per cent efficiency. Since this is not possible either in pump or motor, a combined efficiency of 50 per cent can usually be safely assumed for continual operation. Thus the motor must be larger.

or $41.6/0.5 = 83.2$ Hp for motor.

It must be understood that the above data is taken for illustration and that each case in practice must be considered separately, especially in regard to final size of motor should an induction type be selected. To choose a motor too large for the case saves nothing for the purchaser and materially effects the central station power factor of the system when run light. Thus the final efficiency factor here assumed 50 per cent should be carefully determined based upon operating conditions and characteristics of motor and pump. H. L. WILLIAMSON.

Comment on Ans. Ques. No. 282 in May Issue on Thawing Pipes.

Editor Southern Electrician:

In the May issue Mr. Lindsay's answer to Question 282 is largely in error. Mr. Lindsay is correct in his statement that it is more expensive to thaw a pipe with 110 volts than with a lower voltage, provided the lower voltage will supply the current necessary to thaw the pipe in a minimum time. In the latter part of the statement however there are some mistakes.

A frozen water pipe is thawed by heat electrically applied. The heat dissipated in the pipe varies with the resistance of the pipe and the square of the current sent through it. The heat is propotional to the watts expended in the pipe and watts = amperes $^2 \times$ ohms. Therefore a given current strength (amperes) will produce absolutely the same heat in the pipe regardless of the voltage at which the generator supplying the current is working. If the generator is furnishing a higher voltage than is necessary to send the required current through the pipe, a rehostat must be used to limit the current and energy is being wasted in the rheostat. The wasted energy is greater for the higher voltage, but the heat in the pipe is determined only by the resistance of the pipe and the current passed through it.

E. P. PECK.

Comment on Ans. Ques. No. 282 in May Issue on Thawing Pipes.

Editor Southern Electrician:

Mr. Lindsay's statement with reference to a 220 volt, 400 ampere machine is very misleading and if based on actual experience indicates a wrong interpretation of the observed phenomena. His error is possibly due to having tried to use a 220 volt machine and having failed because of insufficient driving power or other causes which prevented the current from being as large as that delivered by a low voltage machine. The heating effect of a constant direct current in a wire of resistance R is proportional to the power lost in the wire which is I^2R and the voltage at the ends of the wire is IR, whatever the generator voltage may be. The difference between the genrator voltage E and that lost in the wire, IR, is necessarily absorbed in the outside

circuit and is therefore wasted in that it is not used in thawing the pipe or heating the wire as the case may be.

If 400 amperes will do the work of thawing a given pipe at one time it will do it at any time and from any generator of any voltage if the general conditions, such as soil temperature, etc., are the same and if the generator can maintain a voltage of 400R at the ends of the pipe. Of course if the voltage is alternating it would need to be somewhat greater than 400R because of the reactance of the pipe to alternating current.

It is quite possible as Mr. Lindsay says that you may short circuit certain machines, particularly shunt wound generators, through a wire without heating the wire very much, but that is because the machine is not generating either its rated voltage or current when short circuited.

If we have 60 cycle current at 100 volts available and the pipe requires 400 amperes and has an impedance of .025 ohms to 60 cycle current, then the voltage required is $400 \times .025 = 10$ volts. We can get the 10 volts by connecting the primary winding of a 10 to 1 transformer to the 100 volt circuit and taking the current for the pipe from the secondary. The primary current will then be 40 amperes, neglecting the transformer losses. This illustrates the advantage of using A. C. current since with direct it is usually necessary to waste a large surplus voltage in a series rheostat. T. G. SEIDELL.

Frequency of Systems, Ans. Ques. No. 291.

Editor Southern Electrician:

The speed of an a. c. motor is either absolutely identical or, at the most, a few per cent removed from the "synchronous speed" which = (60 × cycles per sec.)/(pairs of poles). Now the number of pairs of poles can, of course, only vary by integers so that every additional frequency of supply greatly increases the speed range of a given line of motors. This view assumes that several frequencies are available in a given supply area but this is the exception rather than the rule so that, although it is convenient to have different frequencies available for various sizes and classes of motors, it is usually the motor which has to be adapted to the available frequency, hence the standard lines of machines for 25, 40, 50 and 60 cycles, (the most usual frequencies in America). There is, I believe, a strong movement in America in favor of 25 and 60 cycles as standards; these values are well chosen and there is no reason why they should not be adopted. In this country, (England) 50 cycles is by far the most common frequency. Thus, among 143 undertakings providing a. c. supply: 5 distribute at 25 cycles, (power); 90 at 50 cycles; 16 at 60; 13 at 80; 4 at 93; and 18 at 100 cycles. Despite the great preponderance of the 50 cycle concerns, I find that the average frequency in the above batch is 60 cycles, a frequency which is admirably adapted for lighting and small power loads but which is too high for large motors and particularly for traction work. 50 cycles appears a better compromise than 60 cycles where a single frequency has to be employed. For traction service a higher frequency than 25 cycles is very undesirable and most of the large Continental schemes have adopted 15 cycle supply. On the other hand 25 cycles is the absolute minimum at which steady electric lighting, (free from flicker), can be depended upon and in a chiefly lighting supply area it is unwise to adopt a lower frequency than 50 cycles. There is little advantage from the lighting standpoint in working with higher frequencies than 60 to 80 cycles. Indeed a. c. arc lamps however well built, are very liable to be noisy if working on circuits of higher than 70 frequency. Filament lamps and mercury arcs etc. operate satisfactorily at 100,120 or even 150 cycles per sec. but from 50 to 70 cycles may be regarded as a convenient range for lighting supply in general and for arcs and Moore lamps in particular, while not being excessive for small motors. The Jandus enclosed flame arc will operate well at all frequencies between 25 and 100 per sec. How the cost of autotransformers is reduced by raising the frequency for which they are designed is shown in the following table:

RELATIVE COSTS OF AUTOTRANSFORMERS.

Frequency	100/25 v. 100 a. Transformer	100/25 v. 15 a. Transformer
40	117	103
50	100	100
60	95	97
80	92	92
100	92	89

Considering a larger class of electrical machinery—say alternators—the saving in prime cost by the adoption of a high frequency is more marked. Thus, taking the cost of a 1000 Kw. machine, (of the 100-250 Rpm. flywheel type), as 1.00, for 25 cycle operation, the cost of a single machine for 60 cycle generation would be 0.75. Corresponding figures for a 5000 Kw. unit are 3.00 and 2.25—thus showing 25 per cent saving in favor of the 60 cycle units. It is necessary to remember, however, that the iron-eddy losses in any a. c. apparatus vary with the square, while the hysteresis losses vary directly, with the frequency of supply. CECIL TOONE, England.

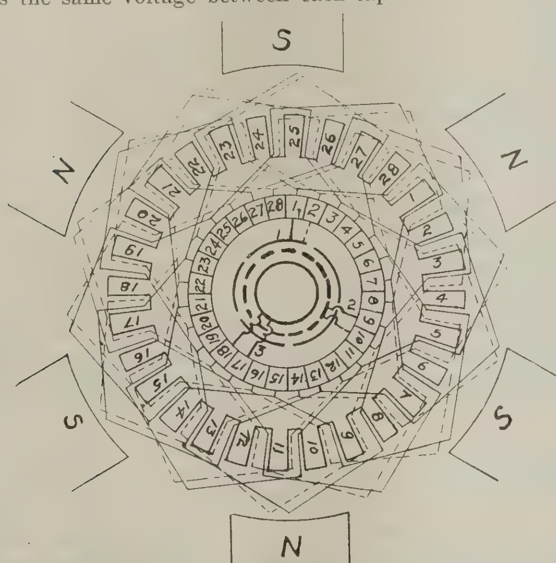
Changing D. C. Generator to A. C., Ans. Ques. No. 292.

In answer to question 292 by L. H. W. in the May issue, I offer the following: A six pole D. C. generator with 28 commutator segments is referred to and we will assume that the machine has 28 slots also. From this date the throw of the coils is 1/6 of 28 or 5, which is the nearest exact figure, therefore the coil will be placed in slot No. 1, and No. 6. Some other slot as 5 or 7 could be used but slot No. 6 seems the best to use. Since the winding is to be a double series or as it is better known as duplex wave, doubly reentrant, the winding will be in two halves that is there are two distinct windings on the armature which are in parallel. This will allow the machine to operate on 100 volts let us say or if the whole winding is put in series on 200 volts. Since there are two seperate windings we will have 14 commutator bars to each winding and we can consider it as such throughout the discussion.

For determining the commutator pitch for a series winding it may be well to suggest that a good rule to follow is to make the commutator pitch a multiple of the number of commutator bars plus or minus ½ the number of circuits divided by ½ the number of poles. In this case it will be seen that with 14 bars to each winding, a two circuit winding and 6 poles, the commutator pitch is $(14 + 1)/3 = 5$ bars so that one terminal of coil 1 must connect to bar 1 and the other end to bar 6, considering 14 bars only and so on around the entire commutator. The other winding must start in the same slot as the first coil of the first winding for the two windings are connected together when the taps for the collector rings are made. If they are not in the same slot there will be a difference of potential between

the coils connected to the collector ring and this will cause a heavy current to flow and injure the armature winding.

The second winding has 14 bars so that it will be connected the same as that of the first, all odd numbered bars belonging to the first winding and all even to the second winding. The proper layout and connections are shown in Fig. 1. The proper bars for the taps to connect to are found as follows: The commutator pitch for each winding is 5 bars, for 3-phase connections this must be divided by 3 giving 2 as the nearest exact figure, therefore the taps should be made to bars 1, 3, and 5 and only one tap to each collector ring is made in a series winding regardless of the number of poles the machine has but to secure the electrical balance 1, 5 and 9 of the first winding must be used and the same for the second. This gives as near as possible the same amount of winding between each tap and thus the same voltage between each tap.



WINDING DIAGRAM.

Now considering the 28 bars, we have bar 1, and 2 connected to one collector ring and bars 9 and 10 to the second ring and bars 17 and 18 to the third ring. If connections are made as in the figure for the case mentioned the writer sees no reason why the machine should not give satisfaction.

Power Factor of Synchronous Motor, Ans, Ques. No. 293.

From the data given by A. C. H. in question 293 of the May issue, the power factor of his synchronous motor comes out greater than unity which is an impossible solution. The power factor of any system is the ratio between the Kw. and Kva., therefore if we have a 3-phase system of say 3600 volts, 39 amps. and 250 Kw., the power factor is $(250 \times 1000)/(3600 \times 39 \times \sqrt{3}) = 102\%$. The general expression for power in a polyphase system is, Kw. $= \sqrt{3}$ EI Cos. Θ, where E is the voltage, I the current and Cos. Θ the power factor.

It is evident that connections to meters in A. C. H's case were wrong or the meters were not in calibration. In answer to the last part of the question, a No. 22 B. & S. copper wire will do for a temporary fuse for 40 amperes and a No. 14 B. & S. for 150 amperes. A general formula for finding the size of wire that different currents will fuse is as follows: D = (I/a) raised to the 2/3 power. In this, I is the amperage and a is a constant, which for copper wire is 10244. D then is the diameter of the wire in inches.

W. D. KELLOGG.

Oil on Motor Windings, Ans. Ques. No. 304.

Editor Southern Electrician:

Oil of any kind whatsoever, is most detrimental to the windings of a motor. Wherever there is an accumulation of oil or oil and dust it causes serious damage to the insulation of the windings, which eventually results in a black fragile carbonaceous looking material that will desintegrate from the conducting wire and result in a partial or short circuit between the wire and core plates, finally resulting in partial burn out of the conductor coils.

The action, due to an accumulation of cotton seed meal on the windings, will be similar to that already described. If R. C. W. is using a three-phase induction motor, in which the air gap is very small he will in great probability have a short circuit and burnt out of the "stator" windings in preference to those of the "rotor" windings; for there is greater opportunity for a permanent accumulation of oil and dust on the stator. The presence of the oil meal will also facilitate the accumulation of any dust or dirt on the windings.

The writer has had an extensive and favorable opportunity to see the detrimental results that in practice result from lack of absolute cleanliness and the entire freedom from all foreign substances that are liable to find their way on the motor windings, having examined and reported on hundreds of cases where motor breakdowns were due to this cause. After a close study of the detrimental results as seen in every day practice, the writer's explanation of the cause of insulation breakdown and complete change of physical structure is, the gradual absorption of the surface oil by the insultation, which is facilitated by the heating of the insulation while the motor is running at medium or heavy loads. The heating causes expansion of the insulating material increases its porosity; and the contraction of the material when the motor is at rest and cools down results in absorption of the oil due to the combined effects of capillarity and contractile stresses. The alternate heatings and coolings of the motor windings over an extended period of time eventually cause oil absorption throughout the entire thickness of the insulating material. The above action accounts for the oil absorption.

The rotting is no doubt due to the decomposition of the absorbed oil by alternate heating and cooling and a possible gassification of the vapor constituent in oil, which results in a chemical action between the insulating substance and oil constituents.

If the motor cannot be totally enclosed, it should be kept scrupulously clean, by wiping and blowing out of all accumulations by a pair of bellows or air under pressure. If the motor could be boxed in, it would prevent the accumulation of oil meal. When boxed in an air inlet and outlet covered by fine gauze to facilitate ventilation of the motor should be provided, a draught of air being conveniently produced by the revolving rotor when in action.

WM. R. BOWKER.

Obtaining Kw. from Watt-Meter Readings, Ans. Ques. No. 305.

Editor Southern Electrician:

Referring to question 305 in this issue on connections and formula for use with G. E. polyphase wattmeter, which you have called my attention to in advance of publication, I would say that, the wattmeter is evidently an indicating meter. If the meter is a standard meter it should read

directly in Hectowatts and should require no constant. If the reading is wanted in watts multiply the reading by 100 and if wanted in kilowatts divide the reading by 10.

The current coils should not be connected in multiple for any ordinary work, but each should be connected in series with one of the lines, when used on three phase tests. When used on single phase tests one elemnt only may be connected in which case the reading will be direct, or the potential coils may be put in parallel and the current coils is series in which case the meter will read twice the watts in the circuit. I do not know of any indicating meter which requires a constant of .64, or in fact any constant except 10, 100, etc. to convert from watts to kilowatts, etc., or a constant of .5, 2, 4, etc. when the meter has several different ranges.

When the meter is used with a multiplier which extends its voltage range from 300 to 600 volts, the readings should be multiplied by 2. Fig. 1 shows proper connections to use for three-phase tests without the multiplier and Fig. 2 shows preferred connections when the multiplier is used. The diagram given in the question will give correct results, but it puts a strain between the two potential coils in the meter which strain is not present when connected according to Fig. 2. It is possible that the multiplier used with the meter is not calibrated for it and requires the constant .64 to correct for its error.

E. P. PECK.

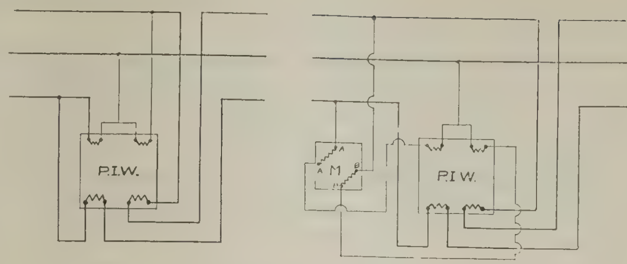


Fig 1. Fig 2.

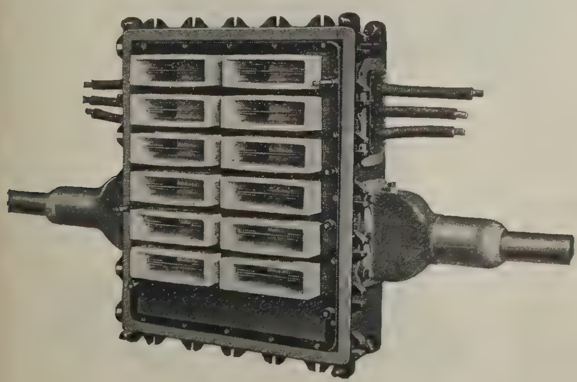
CONNECTIONS FOR METER AND MULTIPLIER.

New Apparatus and Appliances.

A New Cable Junction Box for High Tension Transmission Circuits.

A new type of cable junction box suitable for the interconnection of high voltage feeders and mains is shown in the accompanying illustration, and said to be the first high voltage junction box made in this country. It will be noted that the flexible leads which project through the sides are so arranged as to terminate within the large removable nipple. These nipples have a rounded or dome-shaped end made entirely of soft metal such as lead or lead-tin alloy. This dome-shaped portion is united with that portion of the nipple which is of brass or other rigid material by an exceedingly strong and absolutely water tight joint. The leads are connected to the outermost contact points of each row of disconnecting switches, the innermost point being connected to bus-bars, giving the desired inter-connecting arrangements.

The exposed live parts, that is, those shown in the cut, are isolated in cells of porcelain so that the disconnecting blades can be inserted or removed by means of insulated tongs with a maximum of safety. The porcelain cells are permenently fastened in a metal framework which, inturn, is fastened to the box, in such a manner that a chamber is formed between the framework of cells and the bottom and sides of the box. This chamber, after the carrying parts that enter it are put in place and insulated with tape, when desired, and after the moisture has been removed by the heat and vaccuum process, is filled with a hot insulating compound. Insulating stuffing boxes prevent the compound from oozing out along the flexible leads when the box again warms up under working load. The concealed current carrying parts of the box are, therefore, assembled and insulated before the box is sent out from the factory.



A NEW JUNCTION BOX

In order to make the cable connections, unbolt the nipple from the box, cut off, with a saw or jack knife, the dome-shaped end of the soft metal portion of the nipple, and, after threading it over the cable, joint the conductors to the insulated flexible lead. After this the nipple can be replaced, the joint wiped and the space within the nipple filled with hot ozite insulating compound. when the connection is complete.

As the contact blades, when removed, leave the flexible leads dead, it will be readily seen that in this box one or more of the cables may be connected after the box is in service and while it is alive. This box is adapted for interconnection two or more 1, 2, 3, or 4 conductor cables and may be used for alternating current or direct current circuits. These boxes have been used considerable quantities on circuits of 4500 volts working pressure for a period of nearly two years with satisfactory results. In other installations they are operating at 5,000 volts. The same general design is suitable for still higher voltage.

An interesting reference to the box and its use in one of the largest underground systems in the United States (that of the Pacific Gas & Electric Co.) is given in the April Proceedings of the A. I. E. E. in a paper by Messrs. Lisberger and Wilson. These boxes were originally designed to meet the needs of Mr. Lisberger who is chief engineer of the P. G. & E. Co., and who co-operated with the manufacturer in the design. This box is protected by U. S. Letters Patents and is manufactured by the Standard Underground Cable Co., of Pittsburg, Pa. It presents some new and interesting features which make for greater flexibility and convenience in this class of equipment.

New Pull Receptacle.

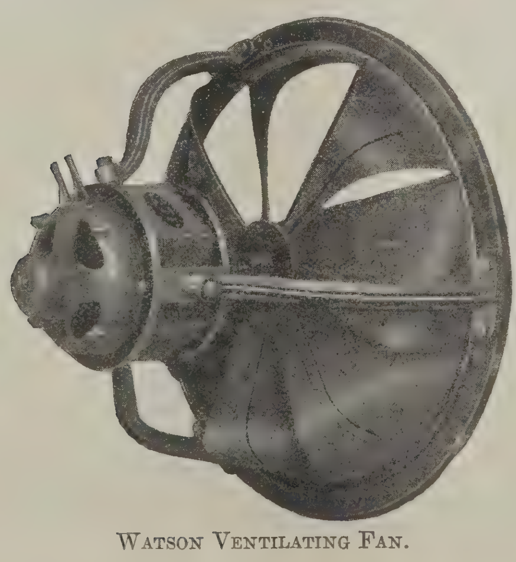
The accompanying illustration shows a new pull receptacle with the Shurlok attachment and Holophane reflector as made by Pass and Seymour, Solvay, N. Y. This pull receptacle may be used as a concealed wall receptacle or in connection with outlet boxes. Two sets of holes are provided for supporting screws so that it can be used on 3¼ or 4 inch boxes. Eighteen inches of pull chain is supplied.

THE P AND S PULL RECEPTACLE.

It will be noted that the Shurlok is unobtrusive and securely protects not only the lamp but the reflector as well, since when the lamp is locked in place the reflector cannot be removed. Any P and S brass shell socket or receptacle can now be furnished with this locking feature.

Watson Ventilating Fans.

The Mechanical Appliance Co. of Milwaukee, known as manufacturer of Watson motors, has recently developed a complete line of motor-driven ventilating fans. The rather peculiarly shaped blades as shown in the illustration below are the result of extensive experimental work and it is claimed that they are both economical and efficient. The motors used are standard Watson type, 1/6 Hp. being used for the 18 inch fan and 1 Hp. size on the 42 inch fan.

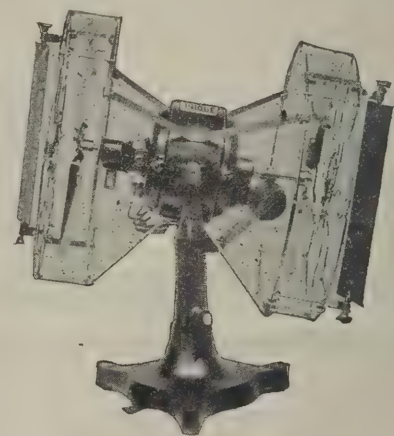


WATSON VENTILATING FAN.

The capacities of the fans vary from 3400 cu. ft. per minute for the 18 inch fan to 20,000 cu. ft. per minute for the 42 inch fan. They are made for direct current and single phase and polyphase alternating current systems.

The Unique Fan.

An electric fan having two fan blades, one revolving about each end of the motor shaft, and gyrating up and down stiring up the air in a room generally, is manufactured by the Unique Fan Company, of Jersey City, N. J. The illustration shown here gives the nature of the design



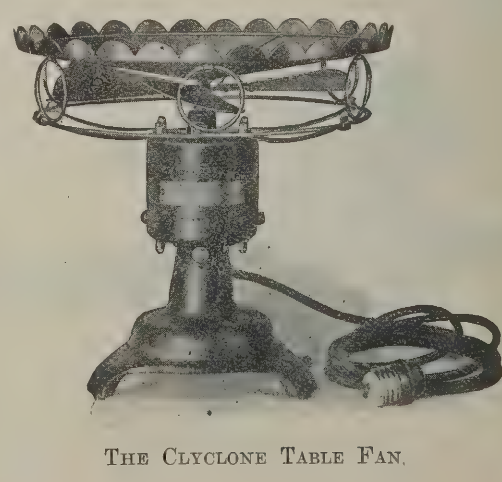
THE UNIQUE FAN.

and arrangement of rotating blades. It is built for desk, ceiling or column attachment. It is claimed that the fan is ideal for a hospital or sick room in that it does not create a draught.

A New Electric Fan.

A new creation in electric fan design has been introduced this season by the Fulton Bell Company of 2 Rector Street, New York. This fan is shown in the illustration and known as the cyclone table fan. It has a deflecting plate above the fan blades which rotate in a horizontal position forcing the air against this plate in such a way as to produce an upward circulation of air.

The design of the fan is such that it can be used on dining tables or at a desk and no objectionable breeze felt. When used on a desk, it is claimed that with the breeze directed upward, loose papers are not desturbed. The motor has three speeds and can be operated from any standard socket.



THE CLYCLONE TABLE FAN.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

ANNISTON. The Alabama Power Development Co. is making surveys for its proposed transmission line from Jackson Shoals to Schmidt's Mill on the Chocolocco Creek.

ATHENS. The city has voted $30,000 in bonds for the installation of an electric light plant. Further information can be obtained from A. P. Henderson, City Engineer.

GEICER. The princess Brick and Building Co. has been granted a charter for the installation of an electric light plant and water works system.

GENEVA. The Geneva Power Co. has filed articles of incorporation for the purpose of building an electric plant in Geneva. D. O. Vaughn and others are the incorporators. The capital stock of the company is placed at $8,000.

HARTSELLE. About $20,000 in bonds will be issued by the city for improvements and extensions to its water works system and electric light plant. The city engineer is A. P. Henderson and other information can be obtained from him.

MONTGOMERY. Reports state that if a permanent injunction is granted restraining the Tallassee Falls Mfg. Co. from interfering with operations on the Tallapoosa River, the Alabama Interstate Power Co. will build a large storage dam at Cherokee Bluff to cost approximately $5,000,000.

SELMA. Plans are under consideration for the installation of an ornamental lighting system on Broad Street. Five lamps standards will be installed.

TALLADEGA. The power plant of the Alabama Power & Development Co. is nearing completion at Jackson Shoals on Coosa River. This power plant will furnish electrical energy to Talladega, Gadsden, Fort Payne, and other towns.

TUSKEEGEE. A central heating and lighting plant will be installed at the Tuskeegee Normal & Industrial Institute. The equipment will consist of boilers, engines, electrical generators, pumps, motors, transformers, and auxiliary equipment. Plans and specifications are being prepared by R. R. Taylor, Director of the Institute at Tuskeegee, and Walter Franz, Consulting Engineer, 1703 Union Trust Bldg., Cincinnati, Ohio.

FLORIDA.

NEW SMYRNA. It is understood that J. T. Hammond is to install an electric light plant with a capacity of about 150 H. P.

WAUCHULA. The Wauchula Mfg. Co. has completed plans for the construction of a new factory to replace the one recently burned. The plans will include the installation of an electric light plant, and energy will be furnished to light the town.

GEORGIA.

AMERICUS. A company has been organized known as the American Power Co., with the following officers: President, Frank Lanier; 1st Vice-President, I. N. McDonald; 2nd Vice-President, C. J. Clark; 3rd VicePresident, J. C. Taylor. An electric light plant will be built at an approximate cost of $50,000.

BLACKSHEAR. A bond issue of $10,000 has been voted for the construction of an electric light plant.

BOWDON. J. B. McCrary & Co. are preparing plans for a water and lighting plant to cost approximately $20,000.

CARTERSVILLE. The city has voted a bond issue of $50,000 for the purpose of extending the electric light system. The mayor is G. W. Young, and other information can be obtained from him.

DALTON. It is understood that the city contemplates the installation of an additional motor at its pumping plant.

ELLAVILLE. The city has awarded a contract for the construction of a municipal electric light plant to the Dysard Construction Co., of Atlanta, Ga.

GEORGETOWN. It is understood that the city is contemplating the purchase of the municipal electric plant of the city of Eufaula, which latter plant is now building a new plant.

JESUP. A bond issue of $35,000 has been voted for improvements to the electric light plant.

MACON. It is understood that plans are complete for the establishment of a $200,000 power plant by the Georgia Public Service Corp. for the purpose of supplying energy to street car systems and lighting in Macon. W. J. Massee is president of the company.

MATHIS. The Georgia Railway & Power Co., of Atlanta, Ga., has awarded a contract to the Ambursen Hydraulic Construction Co., of Boston, Mass., for constructing a reservoir dam across the Talullah River near Mathis. This dam will act as a storage in connection with the main development at Tallulah Falls, now under construction.

VALDOSTA. The Consolidated Ice & Power Co. is planning to double the capacity of its ice, power and light plant.

LOUISIANA.

JENA. It is understood that W. H. Wright and C. C. O'Malley of Winfield, La., are to construct an eletcric light and ice plant.

NEW ORLEANS. The Lynwood Light, Power & Water Co. has been incorporated with a capital stock of $5,000 by G. S. Crockett and L. F. Zeauzais.

ST. ELMO. The Bayou Cane Land Co. is contemplating the installation of an electric lighting plant. I. P. Brady of New Orleans, is president.

MISSISSIPPI.

BILOXI. An electrical engineer in New Orleans has submitted plans for an electric light plant.

OCEAN SPRINGS. A franchise has been granted to H. F. Russell and L. A. Lundy by the city council for carrying on electric lighting business. The electrical energy will be furnished by the Gulfport and Mississippi Coast Traction Co.

JACKSON. The Jackson Light & Traction Co. has been incorporated with a capital stock of $1,600,000 by P. A. Neuffer, H. H. Phillips, and C. J. Horn. The company will operate street railway, electric and gas system.

NORTH CAROLINA.

BANNERS ELK. A hydro-electric plant will be installed by the Lees McRae Institute. The water power site has been located on the Elk River and the development will cost about $5,000 and be of 80 H. P.

HICKORY. It is understood that John Yount of Newton, N. C., has made arrangements to purchase the Boston Shoals and plans to construct an hydro-electric plant.

MURPHY. Plans are being prepared by the Carolina Tennessee Power Co. for a hydro-electric development on Hiwassee River. Two dams are planned and it is intended to erect transmission lines to Murphy and other North Carolina cities furnishing electrical energy for electric light and power. The president of the company is W. F. Cox, of New York City, and the vice-president G. E. Smith of Atlanta, Ga. The engineers submitting reports are Ambursen Hydraulic Construction Co., of Boston, Mass., and W. H. Burr, of Columbia University.

SOUTHPORT. The Southport Light and Power Co., incorporated with a capital stock of $50,000 has organized with H. K. White, president; W. H. Pyke, vice-president; H. Phelps, treasurer, and H. P. O'Hagan, secretary. This company will build and equip an electric light plant.

OKLAHOMA.

OKLAHOMA CITY. The Oklahoma Power & Electric Co. has secured Croslen & Chepelle to prepare plans and specifications and for an electric light plant in which 20 producer gas engines to develop 100,000 H. P. will be installed. The energy will be transmitted to Oklahoma City, to Fort Worth, and Dallas, Texas, and other Oklahoma cities. Steel tower transmission lines will be erected and a transmission voltage of 110 thousand used. The cost of the plant will be approximately $1,500,000, and of the transmission system $1,500,000. The plant will be located on the Blue River at Coal Mine about ten miles Southeast of Durand, Okla.

SOUTH CAROLINA.

SPARTANBURG. It is reported that A. P. Leach Co., of New York City, has purchased the properties of the Electric Power & Mfg. Co., which includes the electric light and gas plant and distributing systems of Spartanburg. It also includes the local street railway and Gadsden Shoals hydro-electric developments from which plant electrical energy is transmitted to Gaffney and other South Carolina cities. It is understood that a reorganization will take place in connection with the Spartanburg company. The purchase price is set at $2,000,000.

PERSONALS.

MR. H. W. YOUNG, Chicago manager of the Sangamo Electric Company, read a paper at the Vicksburg meeting of the Mississippi Electrical Association on "New Developments in Induction Meters" written by Mr. R. C. Lanphier. Owing to the historical character, the paper aroused much interest and discussion at the convention.

MR. M. S. ALLEN, who had charge of the telephone sales work of the Western Electric Co. at Atlanta, during the years 1908, 1909 and 1910, has recently been appointed telephone sales manager for the Northern Electric and Manufacturing Company, Limited, whose headquarters are at Montreal, Canada. He will have entire charge of the sales to all the telephone companies in the Dominion of Canada, whether Bell, Government or Independent. The Northern Electric and Manufacturing Company is to Canada what the Western Electric Company is to the United States. It manufactures practically all of its apparatus, switchboards, subscribers sets, transmitters, receivers, etc., in its great factory at Montreal, disposing of its output through its own distributing houses, which are located at Montreal, Toronto, Winnipeg, Regina, Edmonton, Calgary and Vancouver.

That Mr. Allen's job is a big one, can be understood when it is realized that the business stretches from Newfoundland on the east to the Pacific Ocean and from the Great Lakes to the North Pole. His experience in the South, where he made such an enviable record for himself, will no doubt be of great help to him now. Mr. Allen left Atlanta in January, 1911, to become manager for the Western Electric Co. at Omaha, where he remained until the first of April this year, at which time he left for Montreal. During his stay in the South he became acquainted with most of the telephone people in the States of Virginia, North and South Carolina, Georgia, Florida and Alabama and his many friends will be glad to learn of his latest promotion and to wish him success in his new field.

MR. S. G. MEEK, who was appointed Assistant General Manager of the Electrical Department of the H. W. Johns-Manville Co. on May 15th, has been associated with the company as special representative in the electrical department for a period of over fifteen years, and has the honor of being one of the company's most successful salesmen. Mr. Meek's large acquaintance in the electrical industry will unquestionably be pleased to hear of his recent promotion, and he will be glad to have his friends call at the new 12-story office building now occupied by the company at Madison Avenue and 41st Street, New York, where he will have his headquarters.

MR. CECIL P. POOLE, who has been the junior editor-in-chief of "Power" for the past seven years, has severed his connection with that paper and will engage in consulting engineering in Atlanta, Ga., in partnership with Lamar Lyndon, of 60 Broadway, New York. The firm will operate as the southern branch of Mr. Lyndon's New York office, which will continue as heretofore. The Atlanta office will be conducted by Mr. Poole.

MR. FRANK L. PERRY, who for a number of years has been well known among electrical men as the "electrical wave man of Chicago," has on account of his health been forced to enter less strenuous work. It will be remembered that Mr. Perry experimented with duplex telephony at his laboratory in Chicago, at the same time that announcement was made by Major Geo. O. Squires. In fact he demonstrated a successful system as early as Nov. 4, 1908, some three years before the announcement.

Mr. Perry has recently been called to Baltimore, Md., to become a part of the executive staff of the Fidelity Trust Company, where his work will be mainly along the line of general business promotion and publicity of the company, in which he is an expert.

He is the son of the late Judge Thomas Perry, of Cumberland, Md., was educated in Baltimore, studied locomotive building in the Northern Central shops and was a prize man in mechanical drawing at the Maryland Institute School of Design. His love of science carried him into electrical affairs, and his first experience in this line was in the factory of the old Baxter Motor Company. Later he was appointed electrician of the Western department of the Baxter Motor Company, with headquarters at Chicago. Soon after he became associate editor of the Western Electrician, the leading electrical paper of the West, and finally became its manager. This opened up a large field along the line of original and progressive business methods. So efficient did he become in this promotion work that he was made Western master of transportation for the National Electric Light Association.

H. W. JOHNS-MANVILLE COMPANY, owing to their fast increasing business in asbestos, magnesia and electrical supplies, has found it necessary to move the Winnipeg branch into new quarters at No. 92 Arthur Street, Winnipeg. This is a six-story and basement building, 100 feet deep and 500 feet wide, and will be occupied throughout by the company's offices and store-rooms. By reason of this move, a much larger and more complete stock of goods will be carried on hand than heretofore, and a larger force will be employed to look after the company's interests.

Alphabetical Index to Advertisers.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

Cabinets.

ALMSTEAD MFG. CO., 183-187 N. Water St., Rochester, N. Y. Standard N. E. Code Requirements. Approved May 1, 1912.

CARSTARPEN ELECTRIC CO., Colfax and Broadway, Denver, Colo. Standard N. E. Code requirements. Approved May 1, 1912.

COLUMBIA METAL BOX CO., 226 E. 144th St., New York City. Standard N. E. Code requirements. Approved May 1, 1912.

COMMERCIAL SWITCHBOARD MFG. CO., 1858 Araphahoe St., Denver, Colo. Standard N. E. Code requirements. Approved May 1, 1912.

ELECTRICAL MFG. CO., 1953 Lawrence St., Denver, Colo. Standard N. E. Code requirements. Approved May 1, 1912.

ELECTRIC RY. AND MFG. CO., 84-88 Second St., San Francisco, Cal. Standard N. E. Code requirements. Approved May 1, 1912.

KIRTLAND ELECTRIC CONSTRUCTION CO., 27 Church St., Albany, N. Y. Standard N. E. Code requirements. Approved May 1, 1912.

KRUSE ELECTRICAL MFG. CO., Fort Wayne, Ind. Standard N. E. Code requirements. Approved May 1, 1912.

LANG ELECTRIC CO. J., 423 W. Lincoln St., Chicago, Ill. Standard N. E. Code requirements. Approved May 1, 1912.

STAR METAL BOX CO., 201 Fulton St., New York City. Pressed steel cabinets without gutters for switches or cut-outs. Approved May 22, 1912.

WARDER, CLARK & CHAPLIN ELECTRIC CO., 406 Main St., East, Rochester, N. Y. Standard N. E. Code requirements. Approved May 4, 1912.

Fixtures.

NATIONAL CHAIN CO., 517-523 West 45th St., New York City. A wire-way for flexible cord and substitute for chain pendants in fixture work. Approved May 22, 1912.

NATIONAL X-RAY REFLECTOR CO., 1119 W. Jackson Blvd., Chicago, Ill. Meet standard requirements. Approved May 3, 1912.

SECHRIST MFG. CO., THE ALBERT, 1033 16th St., Denver, Colo. "Sechrist Electroliers," designed to be readily wired and assembled. Approved May 22, 1912.

SHAPIRO & ARONSON, 20 Warren St., New York City. Fixtures meet standard requirements. Approved May 18, 1912.

Heaters, Electric.

CONSOLIDATED CAR HEATING CO., Albany, N. Y. Cross-Seat Car Heaters. Approved May 15, 1912.

PELOUZE MFG. CO., 232 East Ohio St., Chicago, Ill. Electric pressing irons, domestic in 4, 6, 5 and 9 lb. sizes; tailor in 20 lb. size. Approved May 13, 1912.

SYKES MFG. CO., A. L., Cincinnati, Ohio. "Quad" Electric Fireless Cooker, 100 to 800 watts, 125 volts. Approved May 20, 1912.

Panelboards.

ELECTRIC RAILWAY AND MFG. SUPPLY CO., 84-88 Second St., San Francisco, Cal. All types with and without branch circuit switches up to 15 amperes. 125 volt, 2 and 3-wire; 250 volt, 2-wire cartridge link or Edison plug fuses. Approved May 1, 1912.

INDIANAPOLIS ELECTRIC SUPPLY CO., 124 S. Meridian St., Indianapolis, Ind. "Royse," 2-wire, 125 volt panelboards with cartridge or Edison plug fuses. Approved May 14, 1912.

Receptacles, Standard.

KNOWLES, C. S., 7 Arch St., Boston, Mass. Cleat receptacle. Approved May 23, 1912.

PASS AND SEYMOUR, INC., Solvay, N. Y. "P. and S." Porcelain Shell, Key and keyless. Approved May 14, 1912.

SAME COMPANY. "P. and S." wall sockets, brass shell, key, keyless and pull also "P. & S." wall sockets, porcelain shell, key and keyless. Also brass shell types with "Shurlok" attachment. Approved May 13, 1912.

WEBER ELECTRIC CO., Schnectady, N. Y. "Weber" wall sockets, brass shell, key, keyless and pull. Porcelain shell keyless. Approved May 22, 1912.

Sign Machines.

KELLEY AND KELLEY, 105 Liberty St., Brooklyn, N. Y. "Thermo-Blink Tic-Tac" Flashers. A thermal flasher. Approved May 22, 1912.

Sockets, Standard.

BRYANT ELECTRIC CO., Bridgeport, Conn. "Bryant" brass shell, keyless electrolier, twin sockets, candle sockets, pull twin sockets. Approved May 22, 1912.

FREEMAN ELECTRIC CO., Trenton, N. J. Brass shell sockets, key, keyless and pull. Approved May 13, 1912.

GENERAL ELECTRIC CO., Schnectady, N. Y. "G. E." porcelain shell, key and keyless. Approved May 13, 1912.

PASS AND SEYMOUR, INC., Solvay, N. Y. "P and S." porcelain shell sockets, key and keyless. Approved May 6, 1912.

WEBER ELECTRIC CO., Schnectady, N. Y. "Weber" brass shell sockets, key, keyless, and pull. Approved May 13, 1912.

YOST ELECTRIC MFG. CO., Toledo, Ohio. "Yost" key sockets, brass shell. Approved May 25, 1912.

Switch Boxes.

BOSSERT COMPANY, Utica, N. Y. "Bossert" pressed steel boxes for conduit work, knob and tube work, also cast iron gang boxes for push botton flush switches. Approved May 22, 1912.

CLASSIFIED INDEX.

Air Compressors.
Allis-Chalmers Co.

Alarms.
Western Electric Co.

Armatures—Repaired.
Chattanooga Armature Wks.
Oliver Electric & Machine Co.

Ammeters and Voltmeters—(See Instruments—Electrical.)

Anchors—Screw.
Klein & Sons, Mathias.

Automobile Accessories.
L. C. R. Storage Battery Co.

Batteries—Dry.
American Carbon & Battery Co.
Johns-Manville Co., H. W.
Nungesser Elect. Battery Co.
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Speer Carbon Co.
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Batteries—Autocells.
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Batteries—Storage.
L. C. R. Storage Battery Co.

Bell Ringer.
Thordarson Elec. Co.

Boxes—Cutout.
Frank Adam Electric Co.
Bossert & Co.
Chicago Fuse Mfg. Co.
Columbia Metal Box Co.

Boxes—Meter.
Frank Adam Electric Co.
Hart Manufacturing Co.

Boxes—Outlet.
Frank Adam Electric Co.
Bossert & Co.
Chicago Fuse Mfg. Co.
Columbia Metal Box Co.
Cutter Co., The George
Johns-Manville Co., H. W.

Brushes—Motors and Generators.
American Carbon & Battery Co.
Corliss Carbon Co.
Cutler-Hammer Mfg. Co.
Dixon Crucible Co.
Holmes Fibre-Graphite Mfg. Co.
Speer Carbon Co.
Stackpole Carbon Co.

Cable—Aerial Power—(See Wires and Cables.)

Cable Connectors.
Dossert & Co.

Cable—Telephone—(See Wires and Cables.)

Cables—Submarine and Lead-Covered.
Atlantic Ins. Wire & Cable Co.
Hazard Mfg. Co.
Indiana Ruber & Insulated Wire Co.
Moore, Alfred F.
Okonite Co., The
Rome Wire Co.
Simplex Electric Co.
Standard Underground Cable Co.
Waterbury Co.

Cabinets.
Frank Adam Electric Co.
Columbia Metal Box Co.
Wurdack Elec. Mfg. Co., Wm.

Carbons—Arc Light
American Carbon & Battery Co.
Hirschberg, H. M.
Southern-Wesco Supply Co.

Carbons—Brushes.
Corliss Carbon Co.
Dixon Crucible Co.
National Carbon Co.
Speer Carbon Co.
Stackpole Carbon Co.

Chandeliers.
Beardslee Chandelier Mfg. Co.

Circuit Breakers.
Cutter Co.
Cutler-Hammer Mfg. Co.

Cleats—Fiber.
Blake Signal & Mfg. Co.

Coils—Armature and Field.
Oliver Electric & Machine Co.
Chattanooga Armature Wks.

Commutator Compounds.
Goldmark Co., The James

Condensers.
Allis-Chalmers Co.

Conduit Benders.
Rittenhouse, The A. E.

Conduit Fittings.
Bond & Co., H. L.
Electrical Eng. Equip. Co.
G. & W. Elec. Spec. Co.

Conduit—Flexible.
American Conduit Mfg. Co.
Flexible Conduit Co.
National Metal Molding Co.
Tubular Woven Fabric Co.

Conduit—Rigid.
American Conduit Mfg. Co.
Enameled Metals Co.
Gest, G. M.
Johns-Manville Co., H. W.
National Metal Molding Co.
Turner Improvement Co., J. W.

Connectors—Battery.
Cohen & Co., S. M.

Controllers—(See Starters and Controllers—Motor.)

Cords.
Boston Insulated Wire & Cable Co.
Moore, Alfred F.
Samson Cordage Works.
Standard Underground Cabl Co.

Cord—Telephone.
Moore, Alfred F.

Cord—Flexible.
Marion Insulated Wire & Rubber Co.
Okonite Co., The
Samson Cordage Works.

Construction Material.
Southern-Wesco Supply Co.

Cooking Apparatus—Electrical—(See Heating Apparatus—Electrical.)

Cross-Arms.
Hubbard & Co.
Southern Exchange Co., The
Western Electric Co.
Southern-Wesco Supply Co.
Stevens Stave Co., B. F.

Cut-Outs—Arc.
Ft. Wayne Electric Works.

Discs—Telephone Transmitter.
Kellogg Switchboard & Sup. Co.

Dynamos and Motors. .Second Hand.)
Oliver Electric & Machine Co.

Dynamos and Motors.
Allis-Chalmers Co.
Bell Electric Motor Co.
Chattanooga Armature Wks.
Century Electric Co.
Crocker-Wheeler Co.
Fairbanks, Morse & Co.
Kimble Elec. Co.
Ft. Wayne Electric Works.
Mechanical Appliance Co.
Rochester Electric Motor Co.
Richmond Electric Co.
Southern-Wesco Supply Co.
Western Electric Co.
Westinghouse El. & Mfg. Co.

Electric Fixtures.
Beardslee Chandelier Mfg. Co.
Frank Adam Electric Co.

Electric Signs—(See Signs.)

Electric Sign Flashers—(See Flashers—Electric Sign.)

Engines—Steam.
Allis-Chalmers Co.
Fairbanks Morse & Co.
Philadelphia Electric Co.

Engineers—Consulting.
Arnold Co., The.
Byllesby, H. M. & Co.
Dixon-Smith Engineering Co.
Electro-Mechanical Engineering Co.
Fryer, Roy C.
Hallberg, J. H.
Humphrey, Henry H.
Jackson, D. C. and Wm. B.
Mullergren Engineering Co.
Pillsbury, Chas. L.
Scheible, Albert.
Spiker, William C.
Stone & Webster Engineering Corporation.
White & Co., J. G.
Woodmansee, Davidson & Sessions.
Zabel, Max. W.
Zimmerman Co., W. H.

Engravings, Stationary.
Alabama Engraving Co.

Fans—Exhaust.
Century Electric Co.
Fulton Bell Co.
Kimble Electric Co.
Western Electric Co.

Fan Motors.
Century Elec. Co.
Dayton Fan & Motor Co.
Ft. Wayne Electric Co.
Fulton Bell Co.
Kimble Electric Co.
Robbins & Myers.
Southern Electric Co.
Southern-Wesco Supply Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Fibres.
Standard Underg'd Cable Co.

Fire Extinguishers.
Pyrene Mfg. Co.

Fixtures—Lighting.
Beardslee Chandelier Mfg. Co.
Cutter Company, George
Frank Adam Electric Co.
Johns-Manville Co., H. W.
Pass & Seymour.
Phoenix Glass Co.
Southern-Wesco Supply Co.

Flashers—Electric Sign.
Campbell Electric Co.
Reynolds Dull Flasher Co.
Reynolds Electric Co.

Fuses—Electric.
Chicago Fuse Mfg. Co.
D. & W. Fuse Co.
Detroit Fuse & Mfg. Co.
Heineman Co., Geo.
Johns-Manville Co., H. W.
Paiste Co., H. T.

Gas Engines.
Allis-Chalmers Co.
Fairbanks Morse & Co.

Generator Brushes—(See Brushes—Motor and Generator.)

Glass Shades.
Gill & Co.
Gillinder & Sons, Inc.

Globes—Arc Lamp.
Gillinder & Sons, Inc.

Hangers—Cable.
Standard Underg'd Cable Co.

Heating Apparatus—Electrical.
Acme Electrical Heater Co.
Cutler-Hammer Mfg. Co.
Detroit Fireless Stove Co.
National Stamping and Electric Works.
Simplex Electrical Heating Co.

Instruments Electrical.
Duncan Electric Mfg. Co.
Johns-Manville Co., H. W.
Norton Electrical Inst. Co.
Southern-Wesco Supply Co.
Thwing Instr. Co.
Weston Electrical Instrument Co.
Western Electric Co.
Westinghouse El. & Mfg. Co.

Insulators.
Brookfield Glass Co.
Cook Pottery Co.
Johns. Manville Co., H. W.

Insulating Material.
Johns-Manville Co., H. W.
Moore, Alfred F.
Okonite Co., The
Plas-Mica Co.
Standard Underground Cable Co.

Insulator Brackets.
Hubbard & Co.
Stevens Stave Co.
States Co.

Insulator Pins.
Southern Exchange Co., The

Irons—(Electric).
Acme Electric Heater Co.
Cutler-Hammer Co.
National Stamping & Electric Works.
Simplex Electric Heating Co.
Victor Iron Co.
Westinghouse Electric & Mfg Co.

Lamp Cord.
Marion Insulated Wire & Rubber Co.
Moore, Alfred.

Lamps—Carbon Arc.
Fort Wayne Electric Works.
Southern-Wesco Supply Co.
Western Electric Co.

Lamps—Flaming Arc.
Hirschberg, H. M.
Western Electric Co.

Lamps—Incandescent.
The Beers Sales Co.
Hygrade Inc. Lamp Co.

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CONTENTS.

Come to Tybee and Why.

In view of the fact that the N. E. L. A. Committee on Organization at the recent Seattle Convention reported slow progress in the formation of state and geographical sections, the associations of the South now affiliated, have a right to credit themselves with at least an average amount of progressiveness. This is justified by their position in the geographical organization movement, for it was these sections that helped to instill into it a new spirit and span the gap between the early activity and that started anew in 1910. This very fact should excite every central station man to a realization of the possibility before him and his section for a betterment of his conditions through a development of common interests and the promotion of those factors that make more favorable the extention of his business.

In reviewing the progress in the formation of state and geographical organizations, we note that the Pennsylvania Electric Association was the first to become a branch of the N. E. L. A. being organized in January 1908. During the convention year of 1908-9, the New England and New Hampshire Sections were also organized. There then came a lull in the formation of state sections which lasted until the Nebraska Electrical Association and the Georgia Section affiliated in 1910 and the Mississippi Electrical Association in the early part of 1911. The Eastern New York and the Canadian Electrical Association came in during the year thus crediting to the convention year of 1910-11, five state organizations. During the past year, 1911-12, the Northwest Electric Light and Power Association, the Michigan Electric Association, and the Iowa Electrical Association have affiliated making in all eleven state and geographical associations.

It is interesting to note further that in the ten Southern states this side of the Mississippi, namely Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee, and Kentucky, with an area of fifteen per cent of that of the United States and one fortieth of the population, there is at the present time about fourteen per cent of the total number of operating public utility companies. This makes one central station to every two and a half thousand people as against one for every twelve and three-quarter thousand for the United States, excluding the population of large cities. Including Arkansas, Oklahoma, and Texas in the enumeration, these figures are increased to twenty-two percent in number of central stations, in an area one-fourth that of the United States and with a population one-twelfth that of the latter. Thus, while the central station field of the South at the present time does not show up any particular field for extensive and new developments, all systems are expanding on account of the rapid industrial growth now taking place. With the expansion in all industries continuing for the next decade, it is certain that an interesting story will be told. We are not looking for any increase in number of operating companies but a tremendous increase in the electrical horsepower of industries through the activities of those cen-

tralized systems operating hydro-electric properties in a number of the states mentioned.

With the expansion of the central station industry in the South along more intensive lines, the mutual benefits of co-operation through organization are to be more strongly felt. A few states already have associations representing the interests of public service companies in their territories, and while these associations are accomplishing their own work, it is not enough nor commensurate with the real benefits they may work under the proper organization. The joining of all hands of all public service associations in their particular territorial division of the country would extend the good work of each, interfere with none and decidedly benefit the industry as a whole. Let us voice the opinion appearing before in these columns, namely, the South is an important central station field, it is a new one, and the greatest work to be accomplished in it is all before. More organizations representing the interests of territorial divisions are needed in this field, ready to combine their resulting features of investigation and help to make a national body one of its intended importance to the station and to the industry. In short, let there be a Southern Geographical Section of the National Electric Light Association and the central stations whether organized or unorganized join hands to bring this about. Come to Tybee Island August 15th, 16th and 17th and with the forces of the Georgia Section of the N. E. L. A. do something to further, not only your own interests, but those of the industry of which you are a part.

What is Your Capitalization of Yourself?

In these days when the cost of living is running highest in the history of this country, the average employee of a manufacturing plant or other large concern at every raise time, wonders if his advancement is a fair one, or as much as his fellow workers, usually feeling that his firm might have been a little more generous in rewarding him for his work. It is usually thought that the larger the company, the smaller the chance is for fair treatment and advancement. This is, in a large measure, due to the fact that too little recognition is given to the actual basis of the salary received. The wages of 100 workers in a large factory represent the interest on a certain sum of money of which each person contributes a 1/100th part. If therefore each receives $2.00 per day and shirks one half of the time at work, he is allowing the factory to utilize only one half of his ability or one half of the capital which he offered in the agreement and expects to draw pay on. How, then, can such an employee, from the standpoint of an employer, ever expect to be advanced in proportion to the one who delivers to the factory a full measure of time, energy and ability or in other words places at the disposal of the factory management, the exact capital on which his wages were based.

Every employer should urge workers to each capitalize his earning power, and make it plain that in so far as he puts into his work those factors which result in added quantity and quality of products, he can expect to raise that capitalization and the wage or interest based upon it by his employer. In accordance with this reasoning, the management of the Rock Island Railroad makes the following general statement to its employees and places each in a position to know fairly well his earning capacity, thereby increasing his value to himself and to the road.

"You are working for a large corporation. In the nature of things it cannot know you very well personally, but it knows you by the work you turn out. It sets a real value on your work, higher than you think. Your value is measured by the quality and quantity of results you produce. Somebody knows your actual worth, appreciates your honest endeavors and has you in mind for better things. It's a business proposition. Each of us is capitalized.

"Suppose you earn $1,000 a year. At 4 per cent. that is the yearly interest on $25,000. In other words, the company capitalizes you at $25,000 and willingly pays interest on that sum for the use of your energy and faculties.

"It rests with you. Make your $25,000 valuation climb to $50,000, to $100,000, to $500,000. Choose your food with care; treat decently the body on which your mind depends for its strength and sanity. Above all, feed your mind; read, study, observe. Remember, too, that, like the engine, you can't do your work unless you stay on the rails and keep where the boss can find you. No call boy ever found an engine in a saloon or dive."

These suggestions apply to every business and the example which the Rock Island has set may be carefully thought over by every management employing a number of workers.

Cost of Horse, Electric and Gas Delivery.

The Massachusetts Institute of Technology for some time has been investigating the comparative costs of horse delivery, electric delivery and gas car delivery. In securing data, a mechanical record of the performance of each wagon absolutely eliminates the human factor in the problem. A speed indicator was devised with a tape record that showed every movement of the wagon, its actual and its relative speeds at every hour in the day, and also the number of stops and the amount of time the wagon stood idle during every stop. When the record was complete the driver was required to explain the cause of every stop.

The first thing that suggests itself as an outcome to the investigations up to date is that, service requirements are as important a factor in determining costs as is the type of vehicle selected. Every class of service must be considered by itself. For parcel delivery, nine-hour day, three trips, four parcels delivered per mile and with one minute consumed in each delivery, three-quarters of an hour being allowed for loading and the maximum load being half a ton, the horse-drawn vehicle does only two thirds as much work a day as the electric or gasoline truck, at a cost per delivery of 5.9 cents, 5.4 cents and 6.5 cents, respectively. The cost per mile by horse is likewise between the two other costs. In the delivery of coal, which is a very different kind of delivery, at the heavy end of the scale, with loads of five tons, the horse wagon (three horses, one resting every third day) does only about half as much work per day as either of the motor trucks. The cost per mile here runs in much the same way as with the light work, being 55 cents for horses, 47 for electrics and 58 for gasoline, while the costs per delivery are in the same order, $3.91, against $3.32 and $4.07. Some experiments have been made in special service requirements as affecting the cost of operation, and for the parcel delivery two minutes per call has been allowed instead of one. This increases the standing time, reduces the mileage per day, lessens the distance factor and raises the cost on delivery.

Concrete Poles and Test Data on System of Oklahoma Gas and Electric Co.

(*Contributed Exclusively to* Southern Electrician).

BY W. C. BULLEN.

ACCORDING to the latest pole census statistics there are about 3.8 million poles purchased annually by telephone and telegraph, steam and electric railroad and electric light and power companies in the United States. Of this number the telephone and telegraph campanies use about 73 per cent, the electric light, railway, and power companies about 19 per cent and the steam railroad companies about 8 per cent. In past years the largest number of poles used as a whole have been cedar, however the number of this species now used is fast growing smaller, about 60 per cent now being used. Unquestionably cedar leads all wood in presenting the qualities most sought after in pole material and its decrease in proportion of total poles now used is only accounted for by the growing scarcity of cedar timber together with the consequent advance in price.

The woods being drawn upon to take care of the approximately 40 per cent of pole demand include 28 different varieties, with chestnut, oak and pine ranking in the order given. A further interesting fact in connection with the pole situation, is the growing practice of treating poles in order to prolong their life. This practice is being employed at the present time to the largest extent by the electric light, railway and power companies, reports stating that about 30 per cent of poles used have been given some treatment of this character. The present requirements of these classes of users are variously estimated at from 5 to 6 million poles for renewals per year alone, with the probability that this number will in the next ten years increase by virtue of yearly increase in miles of line in operation, making the total annual renewal of wood poles, from 6 to 9 million at a cost of $4,000,000.

The department of agriculture reports that for wood poles, 95 per cent are destroyed by decay, four per cent by insects and about one per cent by mechanical abrasion. The cedar pole is given an average life of 14 years with chestnut 12 years, cypress 10 years, juniper 8 years and pine 5 years. All these woods vary in life according to conditions and are materially effected when treated with preservatives. In the South cypress, juniper and pine have been used to a larger extent due to the nearness to supply and the remoteness of cedar and chestnut. However the demand for these woods for other purposes is so great that even in the section where once plentiful, the supply is rapidly being depleted.

In what has been said the writer has endeavored to present in an unbiased way the wood pole situation and

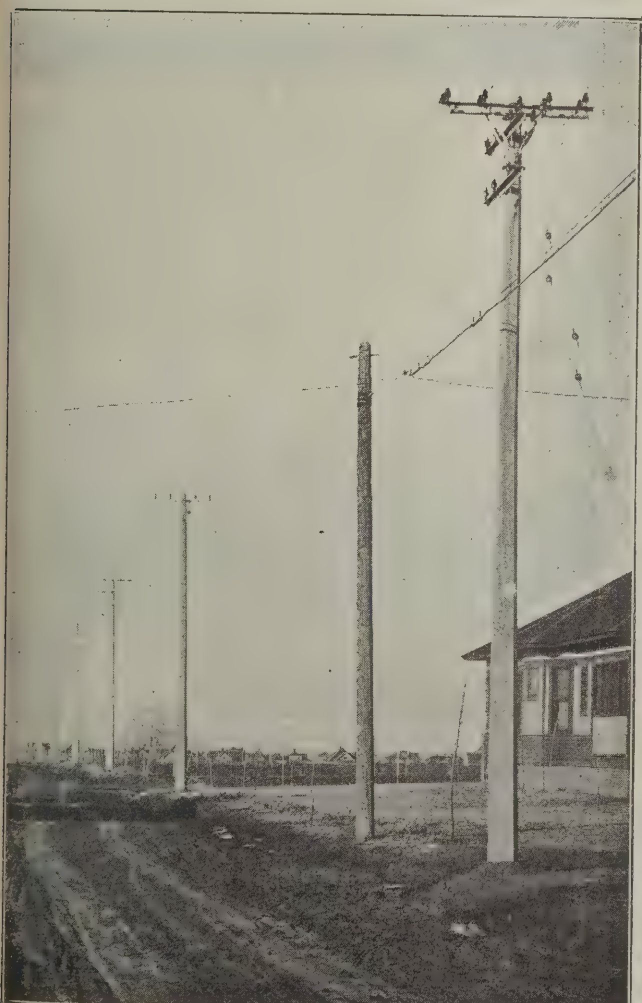


Fig. 1. A Two Circuit Residence Concrete Pole Line in Oklahoma City.

Fig. 2. A Lighting and Power Concrete Pole System in Oklahoma City.

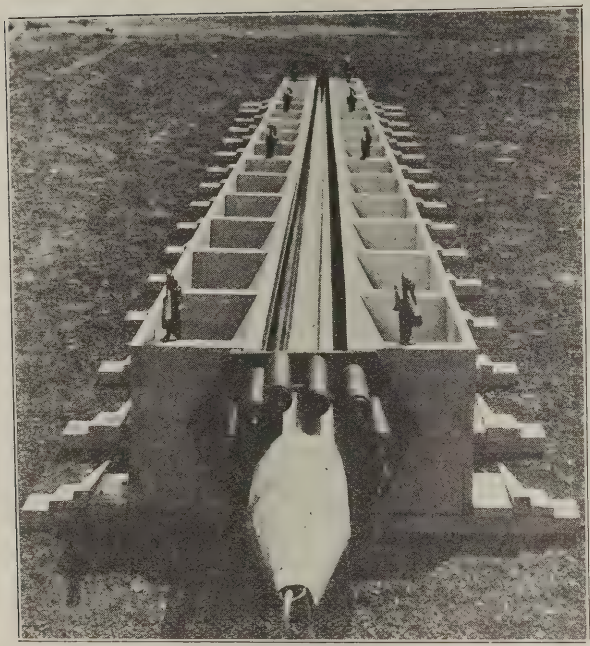


FIG. 3. FORM FOR MOULDING CONCRETE POLES SHOWN IN FIGS 1 AND 2.

lead up to the subject of this article, namely the use of concrete poles by electric light and power companies. The use of these poles has been gradual and with present designs and data on those in service there seems to be an especially important place for them not only in keeping

FIG. 4. COMPARISON IN DESIGN OF WOOD AND CONCRETE POLES.

FIG. 5. AN ALLEY SYSTEM USED IN OKLAHOMA CITY.

the pole sonsumption down but in materially lowering pole maintenance expense.

The illustrations of concrete poles shown herewith are those installed by the Oklahoma Gas and Electric Co., of Oklahoma City, being of the hollow reinforced type. They are hexagonal in section, tapering from butt to top, a 35 foot pole measuring 7 inches at the top and 16 inches at the bottom. Poles of this or similar design are now in service in different parts of the country, the first company to claim their use on a large scale being the United Traction Company, of Albany, New York. In 1904 the Schnectady Railway Company of New York began to use them and in 1906, the western division of the Pennsylvania Railroad built a line of 53 concrete telegraph poles near Naples, Ind., on the route of the Fort Wayne and Chicago Railway. Later this company installed a five mile section with concrete poles through a semi-tidal swamp on the meadows division of the road in New Jersey. These poles are spaced from 70 to 135 feet apart and are from 35 to 65 feet in length. The design calls for transverse loading conditions in case of maximum storms equivalent to 6,000 lbs at 6.5 feet below the top of the pole for 120 foot span. These poles are square in cross-section with chamferred corners, and have a taper of ½ inch in five feet. The reinforcement is composed of mechanical bond bars tied together into a square skeleton frame. In the completed pole this reinforcement is covered by a one inch minimum thickness of concrete. The skeleton reinforcement is then placed in horizontal frames and the concrete mixture poured in. A mixture of 1:2:4 concrete is used which has an ultimate unit strength in compression of 2,200 lbs.

Other companies using concrete poles in considerable

numbers are, the Columbia Power Co., of Columbia, S. C., the Geneva Power Co., Geneva, Wis., and the Dallas Telephone Co., of Dallas Texas.

The poles shown in these illustrations and installed by the Oklahoma Gas and Electric Company are poured in a form as shown in Fig 3. At the small end are three pins placed through the hole in the core for moulding holes in poles for the cross arms. The form is shown with the core in place ready to run in the concrete. The reinforcing rods are shown with plate and long cylinder washers with stretcher bolts on ends of rods in place and for stretching these rods. The core shown is started when the concrete has set sufficiently that it is just possible to make an impression with the finger, and is removed about 6 inches to free from binding when it is left for several hours and then removed. After 48 hours or long enough for the concrete to become hard enough to hold the tension of the reinforcing bars, the stretchers are released and the sides of the form taken from the pole. The pole is removed from the base after 4 or 5 days and can be safely handled. In Fig. 5 is shown a construction used in back yards and alleys. This system is rapidly taking the place of pole lines on the streets in some of the larger cities. In Brooklyn and Rochester, New York, such systems are used, the former city having installed a number of concrete poles. The alley system has advantages further than taking poles off the main street, it wards off the danger of public clamor for under ground conduit in sections where the expense would be out of all proportion to the possible income from the connected load. As shown in Figs. 1 and 2 a concrete pole line, on account of uniformity in design of each pole does not present an unfavorable appearance even on a residence street. Due to this fact and that their appearance changes little with age, and that wood poles are becoming scarce and expensive, the concrete pole system has a decidedly favorable future in solving the distribution problems of central stations.

TESTS DATA ON REINFORCED CONCRETE POLES BY OKLAHOMA GAS AND ELECTRIC COMPANY.

Specifications.	Pole No. 1.	No. 2.	No. 3.	No. 4	No. 5.	No. 6.
Pole length in feet	39.5	39.5	39.5	39.5	39.5	39.5
Pole length above ground line	33.5	33.5	33.5	33.5	33.5	33.5
Distance of load above ground line	33.0	33.0	33.0	33.0	33.0	33.0
Age of pole at test in days	58.0	56.0	52.0	51.0	40.0	46.0
Size of butt in inches	13.5	13.5	15.0	15.0	12.0	12.0
Size of top in inches	7.0	7.0	8.0	8.0	6.0	6.0
Style of core	Round	Round	Round	Square	Solid	Solid
Reinforcing rods	4 7-8" x 40'	4 3-4" x 40' 4 5-8" x 35' 4 5-8" x 20'	4 3-4" x 40' 4 3-4" x 30' 4 3-4" x 20'	4 3-4" x 40' 4 1-2" x 20' Twisted	4 3-4" x 40' Twisted	4 7-8" x 40' Square
Actual total weight in lbs	3820	3860	4824	4240	3400	3500
Load at failure in lbs	1742	1632	1752	1121	2186	2202
Deflection at failure in inches	26.75	18.75	15.50	15.25	56.00	41.0

Fig. 6. Raising and Setting Concrete Poles in Oklahoma City System

TEST ON POLE NO. 1.

Load Applied in Pounds.	Corres. Deflctn. in inches.	Remarks
620	6.75	
968	11.12	Hair cracks began to show.
1084	12.75	Hair cracks increasing.
1186	14.37	Small check lines between 3 and 8 feet from ground.
All wts. relieved.	.375	
620	7.75	
736	9.12	
852	10.56	
964	11.87	
1084	13.50	
1186	14.37	Partial release.
1304	16.00	Checks 3 to 12 feet above ground.
1404	17.25	
1516	21.50	
1626	23.75	Total rupture through butt from ground line to end.
1742	26.75	

TEST ON POLE NO. 2.

620	8.00	
732	9.25	
850	10.50	
966	12.12	
1082	13.50	
1202	14.50	
1314	15.75	
1414	17.12	
1530	18.75	Hair cracks 8 feet above ground. Rupture completely and sudden failure 6 inches above ground line. Concrete below line of rupture broken out longitudinally down the butt.
1632		

TEST ON POLE NO. 3.

620	5.25	
732	6.00	
850	7.00	
966	7.87	
1078	9.37	
1190	10.25	
1306	11.12	No hair cracks.
1422	12.25	Hair cracks from ground to 3 feet.
1522	13.00	Hair cracks 15 feet above ground.
1632	14.50	No additional hair cracks.
1752	15.50	Pole stood about 2 minutes under this load when it failed by complete rupture at ground line with longitudinal cracks from ground to butt.

TEST ON POLE NO. 4.

625	6.62	
749	8.50	
873	9.25	Hair cracks from 3 to 20 feet above ground line.
981	10.25	
1001	11.75	Crack 15 feet, slightly opening.
1121	13.25	Total rupture from ground line through butt.

TEST ON POLE NO. 5.

577	1.00	
1176	7.50	
1372	12.25	First signs of cracks, 10 ft. 6 in. from top of pole.
1500	17.00	Small cracks 6 ft. 6 in. from large end.
1690	23.75	Cracks 4 ft. 6 in. from large end.
1732	25.00	
1794	27.50	Cracks about 1-16 in. wide.
1854	29.50	
2014	36.50	
2022	38.00	
2082	40.75	Cracks become larger.
2108	43.00	Cracks about 1-32 in. wide.
2152	47.00	Cracks nearly 1-16 in. at 15 ft. from butt.
2162	50.00	Cracks become wider.
2180	52.00	
2186	56.00	Began to fail at top at 15 ft. 11 in. from large end; crack at point of failure nearly 1-8 in. wide.

TEST ON POLE NO. 6.

620	12.50	
736	14.75	
852	17.12	
968	19.00	Hair line cracks 2 to 15 ft. above ground.
1088	21.75	
1200	23.50	
All load relieved	1.25	Set.
620	14.50	
736	17.25	
852	19.75	
968	21.50	New hair line crack 8 in. from ground line.
1088	24.00	
1200	26.25	
1312	28.50	
1414	29.75	
1632	31.75	Line opened 10 ft. from ground.
1732	32.50	Hair line crack 3 ft. below ground.
1842	34.50	
1962	36.00	Twice as many cracks but no wider. Cracks open at ground. Rupture and failure 6 in. above ground. Rest of pole recovered to straight line.
2082	41.00	
2202		

Instrument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY E. P. PECK, ASST. ELECTRICAL ENGINEER, GEORGIA RAILWAY AND POWER COMPANY.

Section 8. Test on Generators.

ACCEPTANCE tests on new generators are included in the work a central station testing department is called on to do. Efficiency tests of the generator alone are seldom made, as practically all generators are direct connected to prime movers. The efficiency or economy of the whole unit is what is required and the electrical end of such tests will be taken up. The input, whether to a water wheel, steam turbine, reciprocating steam engine, or gas engine, must be accurately measured. The guarantees on various machines are based on different units. In the case of water wheels the guarantees state the percent of energy delivered, to the energy of the water at the wheel. Steam engines and turbine guarantees give the kilowatt hours per pound of steam used by the engine. Gas engine efficiencies are based on the number of British Thermal Units per kilowatt hour. The generators are also guaranteed as to regulation and heating.

Since these tests determine whether or not a very costly machine is up to its guarantee, it is imperative that all instruments used be accurate within very small limits. Unless the testing department has available precision standardizing apparatus for checking the portable instruments to be used, such a test should not be attempted. The portable instruments used should be checked just before the test is made and if there is any question in regard to the results, a re-check should be made at the completion of the test. Switchboard instruments as received from the factory should never be assumed to be accurate enough for an acceptance test. Such tests are very costly to make and if any appreciable error is present the test is misleading and useless.

The equipment given in the articles on the "Standardizing Laboratory" and "Portable Instruments" was designed to care for these tests as well as the other tests taken up in previous articles.

The duration of the test will depend on the type of prime mover and the accuracy with which the readings may be made. On the electrical end, three or four hours after the machine has been properly heated up, may be long enough if the load is steady, but a much longer run is neces-

sary if the load is fluctuating. Readings should be taken at frequent intervals, say 10 minute intervals for a three or four hour test or for a longer test on fluctuating loads. If the load is very variable an accurate test is almost impossible as a true average of the readings is difficult to obtain.

It is well to work out the data as the test progresses as in this way any variation in conditions will be noticed and if there is any large difference between the results obtained and the expected results, the reason for such decrepancy may be found before the test has run any great length of time. It is extremely annoying to make a test of this kind and find out, after the test is completed, that some point has been overlooked or that some gauge or meter has gone wrong or been improperly read, thus vitiating the whole test.

There is a difference of opinion regarding the use of watthour meters on such tests. If the watthour meter can be calibrated in position with all essential conditions the same as they will be on the test, it is undoubtedly best to take its readings. The error in the watthour meter may be greater than the portable instrument error, but on fluctuating loads the watthour meter readings will come nearer giving the true average load than will an average of the periodic readings of portable instruments. In any case watthour meter readings offer a valuable check on the other readings.

A large number of experienced men are necessary on these tests for reading the instruments, gauges, etc. All readings which are vital should be taken simultaneously. Each observer should have a pad, with columns ruled and marked for each instrument he is to read. The instrument number, time of reading, and reading of instrument should be entered and each man should sign his sheet before turning it over.

DIRECT CURRENT GENERATORS.

The output of a direct current generator is best measured with an accurately calibrated millivoltmeter and shunt and a voltmeter. If the current output of a generator is large—1,000 amperes or over—the check of the ammeter will involve some difficulties. The portable millivoltmeter and shunt must be checked in the Laboratory directly against the primary standards. Some portable shunts have a calibrating resistance connected from the shunt proper to the binding posts for meter connections, other shunts are adjusted to give the exact milli-volts drop at the shunt terminals. If the shunt to be used is of the first type, it is necessary to connect the shunt and millivoltmeter as for service, and to compare the readings of the combination with the readings of the potentiometer and standard low resistance. The milli-voltmeter should previously have been adjusted to read correctly as a milli-voltmeter. If any adjustments are necessary when used as an ammeter they are made by changing the calibrating coil in the shunt.

If the shunt is of the second type mentioned, it may be checked as described above or the milli-voltmeter and shunt may be checked separately. For very large shunts the latter check is sometimes easier to make as checks of the shunt resistance may be made with a lower current than is necessary for a check as an ammeter.

The shunt is connected in series with a low resistance standard and readings are taken with the potentiometer alternately across the shunt terminals and the standard resistance terminals. Checks should be made at several different current strengths and a number of readings taken at each value. The average of all readings is used as the true result. The current should be high enough to read to four figures on the potentiometer.

The resistance of the shunt is obtained from the resistance of the standard. $I = E/R$, $I = e/r$. The current is the same in both instruments therefore $E/R = e/r$ and $R = rE \div e$. where R = resistance of shunt; r = resistance of standard; E = Milli volts drop on shunt; e = Milli volts drop on standard. Having measured the resistance of the shunt, the milli-volts drop for full load current is easily figured by Ohm's law.

When making the checks in the Laboratory and when using the meters on the station test, there are three chances of error which must be guarded against. Since the current is large, the stray fields are large and the portable instruments must be placed at a distance from the heavy leads. The leads should also be laid close together.

Temperature errors in the shunt are very liable to be present, and if such are found it will be necessary to check the shunt, on the current to be used on the test, after it has been in circuit long enough to reach a stationary temperature. The leads should be connected to the shunt in exactly the same manner when it is checked as when used in the station. If this is not done the current will not distribute through the shunt in the same manner in both cases and an error will be introduced.

The voltmeter check is very simple, the check being made against the potentiometer and volt box, but when used in the station the same precautions, as to stray fields, should be taken with it as with the milli-voltmeter. Tests for stray fields and a method of averaging the error out have been given in a previous section.

ALTERNATING CURRENT GENERATING TESTS.

The output from alternating current generators is measured with wattmeters. Voltmeters and ammeters should be in circuit also. The voltmeter is necessary for holding the proper voltage on the generator and is used in conjunction with the ammeters for obtaining the power factor. Current transformers and potential transformers are necessary for all high voltage tests. All of the meters should be carefully standardized as secondary meters and should then be checked with their transformers. Care should be taken to use the meter on the same transformer with which it was checked, and with the same leads from the meter to the transformer. The error of the meter and transformer at different parts of the scale should be plotted as a curve and corrections applied accordingly on the test. Directions for making primary checks of the combined meter and current transformer were given on Page 191 of the May issue in the section on "Checking Watthour Meters."

The connections for three phase generator tests are shown in Fig. 1. As the machine is separately excited, the field losses are added to the generator output, but the field rheostat losses are not included.

HEAT RUN.

Temperature measurements may be taken on the generator during the efficiency test and a separate heat run need not be made. Thermometers are placed on the armature iron and conductors before the test is started, and temperature readings taken at the time of the other readings. It will be necessary to continue the full load

run until the temperatures have become constant. The overload runs are made, at the load and for the time given in the specifications, immediately after the full load heat run.

At the completion of each run, the load should be taken off and the machine shut down as quickly as possible. Thermometers are then placed on the revolving fields and these as well as thermometers on the armature are closely watched. On many machines the temperature as shown on the thermometers will rise for a time after the machine is topped. The reason for this is that air currents have cooled the surface parts to a lower temperature than the interior and the heat tends to equalize in all parts of the coils and magnetic circuit when the machine is stopped.

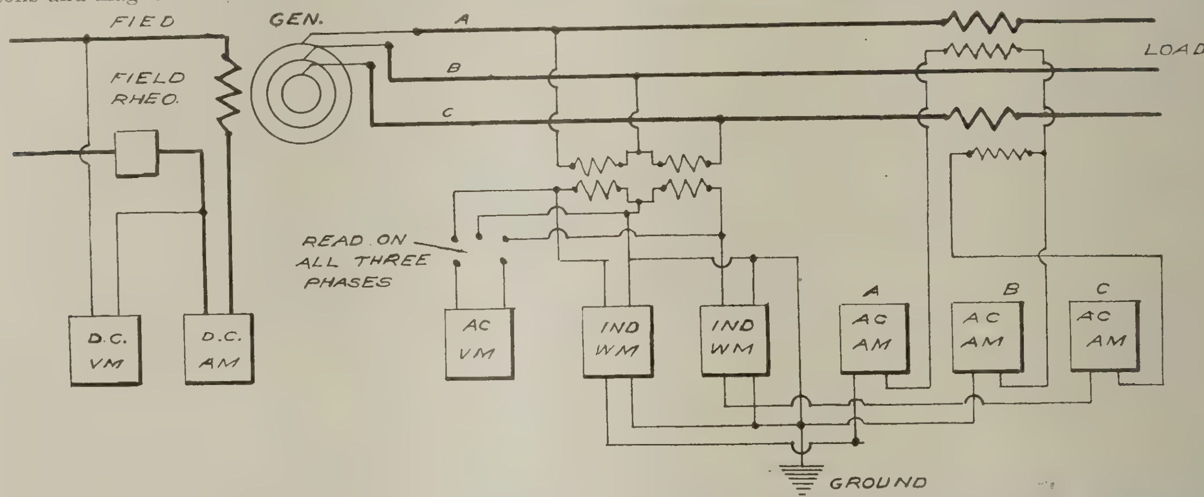


Fig. 1. Diagram of Connections for Output Test of Three-Phase Generator Showing Instruments Required.

When the temperatures have reached a maximum and remain constant, readings should be taken.

It is very difficult to measure temperatures on steam turbo-generators on account of the air blast from the revolving parts and great care must be taken in placing the themometers and shielding them from the air currents. As turbo-generators run for a long time after steam is shut off, a temperature measurement made after the machine has stopped cannot show the maximum operating temperature.

The cooling air for turbo generators is usually taken from outside of the power house, and the temperature of the air at the intake should be taken as room temperature. The cooling air temperature is the one to use in figuring the temperature rise of the generator. The temperature rise should be reduced to an air temperature of 25 degrees C., as explained in the article on "Transformer Testing" in the June issue.

REGULATION TESTS.

Close regulation of alternators is not considered as important now as it was formerly, particularly in large generators. It is well however to make this test with the other tests. The regulation of the generator alone is measured, with the speed the same at no load and full load. This condition is sometimes difficult to get and the regulation of the generator alone is not the true regulation of the whole unit. The regulation desired includes the variation in speed of the prime mover and should be measured at constant steam pressure or water head. The regulation of the unit is the ratio of the difference in voltage, at full load and no load, to the full load voltage, with a constant pressure or head on the prime mover. The load should be gradually reduced when making this test in order for the governor to have time to act. If desired the speed regulation of the machine may be seperated from the voltage regulation,—an accurately calibrated tachometer being used to measure the speed. The formula for figuring the regulation was given in the article on "Transformer Testing" in the July issue.

INSULATION TESTS.

Insulation tests should be made on both field and armature coils. The A. I. E. E. Standardization Rules recommend that "The test for field windings should be based on the rated voltage of the exciter and the rated output of the machine of which the coils are a part." The voltage applied to the armature should vary with the rated voltage of the machine and its size. The following tables gives the A. I. E. E. recommendations as to test voltage.

Rated Terminal Voltage of Circuit.	Rated Output.	Testing Voltage
Not exceeding 400 volts	Under 10 Kw.	1,000 Volts.
Not exceeding 400 volts	10 Kw. and over	1,500 Volts.
400 and over, but less than 800 volts	Under 10 Kw.	1,500 Volts
400 and over, but less than 800 volts	10 Kw. and over	2,500 Volts
800 and over, but less than 1,200 volts	Any	3,500 Volts
1,200 and over, but less than 2,500 volts	Any	5,000 Volts.
2,500 and over,	Any	Double the normal rated voltage.

The test voltage should be raised slowly to its maximum value, held constant for one minute and gradually reduced. Other information on insulation test is given in the article on "Transformer Test" in the July issue.

WATER RHEOSTATS.

The load which the generator regularly supplies may be used as the load for a test provided that the load may be held at the desired values, and that it is constant and has a suitable power factor. If the conditions are such that the regular load may not be used it will be necessary

to provide a rheostat for the load. The water rheostat is found most suitable for large amounts of power. Absolutely pure water has an extremely high resistance but city water and water in rivers and ponds usually contain enough impurities to be used, without the addition of any chemicals, in rheostats for 2,200 volts and over. Rheostats for use with 110, 220 and 550 volts generally require the use of some chemical, such as salt, some of the alkalies or some of the acids, to reduce the resistance to the required value. Water varies greatly as to the amount and character of its impurities so that the dimensions of a high voltage rheostat suitable for one location would probably not be right for another location.

For a small ammount of power a water rheostat may be made of pipes, immersed in the water, which are spaced apart and held in position by a board with holes bored in it. For large amounts of power the pipes would be replaced with plates. The current is adjusted by immersing a greater or less surface of the plates in the water. In a river or large pond the spacing of the plates, beyond a small limit, has very little to do with the resistance between the plates. If a box or barrel is used for holding the water, the current may be adjusted by raising or lowering the plates into the water or by changing the separation of the plates.

The writer has used a rheostat composed of three plates of sheet iron immersed in a pond water for tests on 2,200 and 6,600 volts, three-phase generators for loads up to 3000 Kw. For the 2,200 volt test the spacing of the nearest parts of the plates was about eight inches and for the 6,600 volt test the spacing was about four feet. These spacings were taken arbitrarily and were entirely satisfactory.

The load was adjusted by varying the amount of immersion of the plates. An area of 7,800 square inches per plate (both sides) was necessary for 3,000 Kw. at 2,200 volts, and the 6,600 volt plates had about 3,000 square inches immersed for 3,000 Kw. Under some conditions one square inch of plate surface per ampere may be used, but in the rheostats mentioned above, a much greater surface was necessary to obtain the load. As these plates were placed in a large pond no trouble was experienced from heating. Had they been used in a tank, cooling water would have been necessary. One kilowatt will evaporate 3.53 lbs. of water per hour, therefore this amount of water will be necessary to replace the water boiled off. If the water is not allowed to boil more cooling water will be required. This neglects the energy required to raise the water to 212 degrees and also neglects the heat energy radiated by the water.

For the low voltage rheostats, barrels will probably be found most convenient. A barrel rheostat will carry up to 100 amperes without excessive boiling, but the load must be kept very much below this figure if boiling is objectionable. The resistance of the solution decreases as the temperature rises and it is necessary to be very careful when adding the salt. It is well to place the plates close together and add the salt in solution very slowly, for as soon as the rheostat begins to heat with the load, the current will rise rapidly and it may be necessary to overflow the barrel with fresh water in order to hold the current down in case too much salt has been added.

Another useful rheostat is made of coils of iron wire submerged in water. A rheostat of this kind may be made to carry the greater part of the load and water rheostats used for adjusting to the required current. The following table, which was published in the American Electrician gives the carrying capacity of iron wire in water.

B. & S. Gauge.	Amperes.	Feet per 110 volts.	Feet per 550 volts.	Feet per pound.
20	36	25	...	309
19	42	27	...	293
18	50	29	...	232
17	60	30	...	164
16	71	32	...	146
15	88	34	...	107
14	103	36	...	91.9
13	122	38	...	72.1
12	145	40	200	57.8
11	173	42	210	45.8
10	205	45	225	36.4
9	245	47	235	33.3
8	293	58	290	25.0

A continuous supply of cooling water is necessary if the wire is placed in a small amount of water, the amount of cooling water depending on the energy dissipated as explained above.

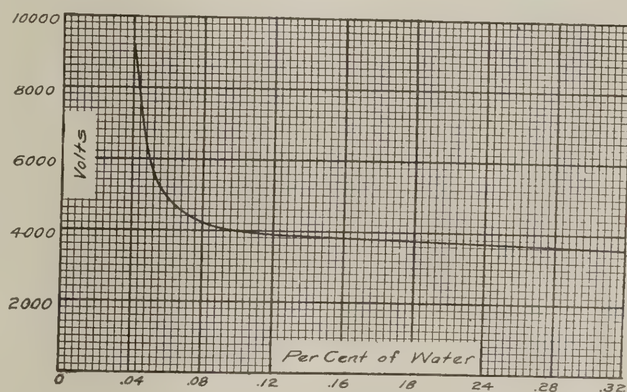


Fig. 2. Curve Showing Effect of Water in Oil.

This is the curve referred to on page 292 of July issue as Fig. 7 but omitted.

Lighting the Panama Canal.

According to an announcement of Isthmian Canal Commission, work on the project for lighting the canal and placing buoys and day marks was begun in April, 1911, and it is advancing in accordance with the schedule made in June. Surveys and clearing the land of obstructing trees and foilage are almost completed, and the construction of range-light towers is under way. The scheme of illumination contemplates the use of range lights to establish direction on the longer tangents, and of side lights placed about one mile apart to mark each side of the channel. The range lights are omitted in Culebra Cut, where their use is hardly practicable, and on four of the shorter tangents on the remainder of the canal. The project includes a light and fog signal on the west breakwater in Limon Bay, a light on the east breakwater, should it be built, and gas and nun buoys lighting and marking the channel to the Mount Hope Dry Dock. Acetylene gas will be used for the lighted buoys in all the sections of the canal and for the beacons in the Gatun Lake section. For the beacons in the Atlantic, Pacific, Miraflores, and Culebra Cut sections, electricity or acetylene gas is to be used.

Fire Prevention as Affecting Power Plant Design and Operation.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY W. J. CANADA, ELECTRICAL ENGINEER FOR ROCKY MOUNTAIN FIRE UNDERWRITERS ASSOCIATION.

THE almost unanimous complaint against unduly high fire insurance rates, which has come from electrical operating companies for several years has now brought about a more positive and productive effort to eliminate the unnecessary fire hazards in power plants. How many such hazards commonly exist, will surprise the management which really undertakes to weed them out. That they should have passed unnoticed so long is largely because of the fact that operators are accustomed to dealing with business factors which may be measured in percents of investment or of income. A minute analysis of minor features is only recently being recognized as effecting final results. With this recognition has come more general adoption of sinking funds, caution of bond buyers as to franchise periods, and finally the beginnings of power plant fire prevention.

When in company with a trained fire prevention engineer, a plant manager takes his first survey of his fire risk in other than generalities and vague accusation against fire insurance companies, he will observe that certain hazards are common to almost all stations and that carelessness in design and operation may be generally held to account. To bring this conviction fully home to a manager accustomed to think in terms of machinery coal, wages and investment, the fire prevention engineer must have more than a passing acquaintance with the actual engineering features involved in the operation of plant and the sale of its product. His suggestions on reduction of fire hazard will then maintain a convincingly rational relation between feasible improvements in fire risk, and those reductions in fire hazard which might possibly involve inefficient station operation.

Where stations are now being erected, it is increasingly rare for plans to be passed on or buildings completed without submission to fire insurance bureau engineers. But with a present investment throughout the country in power plants and substations of nearly a billion dollars, the pressing problem becomes the minimization of existing fire risks. The economic question involves the loss of buldings and machinery to certain varying amounts yearly, the country over, distributed among many insurers if insurance is carried, or falling heavily on investors where by some short sightedness no idemnity has been purchased. Even greater loss usually results from failure of service, falling off of income, permanent adoption of other service by injured customers and like contingencies.

The problems of fire insurance and fire prevention group closely together, one analysing fire causes, the other applying charges in fire rates adequately covering the proportion of total fire loss throughout the country due to particular defects. The impulse for fire prevention ceases to deal in generalities and becomes a scientific method only by reasonable compilation of loss causes in a definite manner. In this way fire prevention draws its data from insurance records and insurance ratings should indicate the best points to attack the question of fire prevention.

With the increasing number of total recorded power station fires, and more accurate data on causes and courses of these fires, the analysis in fire rates becomes closer and measures of particular hazards more equitable. It naturally results therefore that the balance of as yet unanalysed hazard grows constantly less. Such a balance, usually called the basis rate of any schedule, is somewhat comparable with that charge which under various disguises of minimum rate, readiness to serve, maximum demand, or other title, forms the base or nucleus of practically all electric service rate systems. Contrary however to these service rate bases, the insurance rate bases throughout the country are constantly dropping.

A particularly radical departure in this direction is seen in the power plant schedule recently adopted in the central and western states. Full insurance is taken as a basis for equitably dividing the total yearly fire loss of power stations in proportion to values at risk in different locations. A plant without any of the analysed hazards may thus pay a contribution of only 8 cents per hundred of insurance toward the total fire loss. As electrical machinery and apparatus is somewhat more damageable its minimum contribution under this schedule was placed at 15 cents. Such a schedule makes every inducement, from an insurance standpoint, for the safest of constructional and operative conditions, where older schedules included in their bases many structural and even occupational hazards, to remove which no assigned measurement of hazard could be adduced as argument by the fire prevention engineer. Fire hazards in power stations naturally group themselves about construction, arrangement of apparatus, heat, light and oils, and condition of fire protection devices as supporting and propagating combustion and as varying the damageability of the structure. Walls of brick or stone of thickness increasing with height offer neither active hazard, support for combustion or much damageability. Roofs supported on unprotected steel members are superior to those on wood trusses and particularly to those of joisted construction, but the steel supports are themselves improved by fire-proofing. The use of wood sheathing in roofs, or of wood partitions, or of wood floors, particularly joisted floors, offers material for combustion, and increases damage both to building and contained apparatus. Concealed spaces in frame walls, partitions, roof or floors aggravate the fire hazard by making extinguishment difficult. The use of skylights or ventilators with wood framing, strips, shutters, or even sash, places combustible material in a location exposed to sparks from both within and without, and in a position unusually difficult of access for effective fire fighting.

The disposition of power machinery and auxiliaries affects the fire hazard both as these are active fire causes and as they distribute fire and are themselves subject to damage because of location in the builidng and near other apparatus where either is combustible. Boilers should be

isolated from other apparatus both as sources of fire and because in firing, coal dust may accumulate and increase probability of spread of fire on electric machines, switchboards and wiring. The adjacent coal bunkers also add a large amount of fuel, frequently aggravated by wood construction in the bin itself. If the boiler room is entirely noncombustible, the communication of this room to engine room by ordinary self closing doors instead of fire doors imposes little hazard upon engine room or contents. Steam engines may generally be considered as adding no appreciable fire hazard, unless by contact with wood floors, or passage of headers through wood ceilings, both of which are really structural defects. Generators and exciters should be kept in dry clean places away from combustible floors or wire and pipe pit coverings. The danger of wood flooring about generators is generally aggravated by its more or less oily condition.

The disposition and character of station wiring from machines to switchboards and thence to outside lines not only largely affects the general hazard of the station and the susceptibility to injury of the wiring itself but may with comparatively low initial loss cause an entire shutdown of the plant. The method too frequently followed even in modern stations, of running groups of cables with combustible insulation through pits with removable wood covers and even with wood racks for wire supports, may be expected to result in occasional fires of great severity and difficulty in extinguishing. Such a loss caused serious embarrassment for weeks to the service of the Pueblo Suburban Traction Company, of Pueblo, Colorado.

The use of combustible insulation at rear of station switchboard is less dangerous only because of greater accessibility for cleaning and fire fighting. Wires generally unless run in separate ducts or conduits, should be provided with fire retardant covering.

Switchboard design has long been such as to minimize the probability of fires originating at this point or of spreading, except as combustible connecting wiring or skeleton wood framing for switchboard auxiliaries offers food for the flames. The replacement of such frames by skeleton iron is rapidly coming into use in those stations whose management are getting in line with fire prevention methods. In Colorado five stations are now undergoing this treatment.

Lightning arrestors and oil switches lose most of their hazard when all the combustible insulation and frame work is removed to a safe distance, but the considerable distance required where arrester or switch operates on high tension circuit becomes so great as to be impracticable in buildings of ordinary area. Insurance schedules now call for all such apparatus above 6,600 volts to be placed in fire proof rooms or compartments with fire doors separating from rooms containing other apparatus and this practice is receiving general support.

One of the hazards impossible to entirely guard against is the presence of oils covering transformer coils which may at any time, due to atmospheric or line disturbances, develop a persistent ground or short circuit arc. Entirely non combustible floors, well drained to carry away over flowing oil, and complete isolation in fire proof rooms with tight fitting fire doors and raised sills, offer the best assurance against large station losses from these periodically recurring oil transformer fires. The destruction, three years ago, of the Southern Colorado Power Company's plant at Trinidad, started in a transformer on wood floor, by puncture of insulation from overload—spread by overflowing of burning oil through open doorway to engine room, and along wood covered wire pit to switchboard, bringing down the wood sheathed roof and its steel truss frame within twenty-five minutes and barely giving time for shutting off of engines and pulling of boiler fires. The reconstructed station, now owned by the Trinidad Gas and Electric Transmission & Railway Company has naturally avoided each one of these fire inviting conditions. Previous to the fire no insurance was carried. This mistake has also been avoided by the succeeding operators.

Where in improving upon existing hazardous conditions the removal of wood sheathing or even of suspended wood ceiling is not immediately feasible, wood work should at least be cut away to 18 or 20 inches from boiler stacks and ventilating hooded sleeve provided. Some stations have been observed where two or three successive fires were extinguished in surrounding wood work, before a negligent management authorized the above palliative.

The larger central stations usually contain other than purely station apparatus. Generally a small machine shop, minor supplies and storage of oils will be found. Supplies should be carefully watched to limit the amount of combustible material, clean waste, insulation, tape and the like. Oils should be kept in a separate room outside the station proper. Most oils will burn if temperature becomes three or four hundred degrees, and in burning become spreading sources of fire. It is usually possible to limit the amount in the station proper to a few pump type metal cabinets or to all enclosed metal central oiling systems. The practice of oil separation from oily waste is particulary bad if associated with wood flooring,neighboring electrical apparatus or wiring.

The disposition of oily waste in self-closing metal waste cans is important. Some oils and greases in finely divided form as on waste become rapidly oxidized and develop heat suffiicient to ignite them. Or a match may accidentally start waste charring, and only its isolation in riveted can raised on legs and with cover always on will prevent communication of flame to wood floor or pit covering.

The same objection applies in less degree to clothing of engineers and firemen, which if stored in wood lockers, on wood partitions or even on brick walls, offers combustible material for the spreading of fire and has often originated fires by spantaneous combustion.

The use of open lights, candles torches, or of stoves is fortunately becoming rare, and offers such obvious hazard that its recognition by central station operators calls for no argument, and removal is readily secured.

After every practicable elimination of active hazards or features increasing damageability has been made, there are still to be considered those fires which still spring from unsuspected and yet unanalysed causes. Because care in hazard elimination has been given is no excuse for the neglect of provision for fighting fire where it does occur. Chemical fire extinguishers are of value in limiting water damage when extinguishing small fires. The small pump extinguishers are especially useful in electrical fires due to non-injury to electrical apparatus, and the insulating character of the fluid employed. Sand pails are also within limits, efficient fire protection devices. The stand pipe and hose, because of the extent to which water damages electrical apparatus, have really no room in

modern station design; but they may still become indispensable where wood sheathed roof, wood floor, or frame walls makes the station building a combustible enclosure only. In that case large quantities of water may be the only method of checking fires in the building itself.

It is of the highest importance where water protection is necessitated by defective building construction, to insure ample supply by large circulating mains able to supply large demands at effective pressures.

Having eliminated as many hazardous features as possible and installed fire protection most suitable for the character of building construction and apparatus, a station manager has assurance of operating continuity which together with insurance reduction attendant, will rarely fail to show a satisfactory return on investment for changes. Of course where all such features are checked as building is erected and apparatus arranged, the cost increase over the more ordinary defective conditions will be found comparatively slight, and to pay correspondingly greater returns than subsequent replacements and rearrangements.

As with all other classes of business, the effectual separation from low hazard, large value, highly damageable apparatus of all those portions which offer large probability of fire inception and spread, is the one great object in fire prevention, fire minimization and fire fighting. When the active fire causes of the station itself have been isolated, the isolation of the station as a whole from possible outside fire causes should be sought. The simple expedient of using wired glass windows in metal sash and frame for exposed windows, and of roller steel shutters for exposed door openings is strongly advisable where exposing frame buildings are within thirty to forty feet, and brick buildings within twenty feet.

That the fire prevention or protection devices, waste cans, fire doors, metal window sash and frames, fire hose, chemical extinguishers may be assuredly of the best material and design is of course of first importance, and the devices examined, tested and labelled by the Underwriters Laboratories should be specified. Most underwriter inspection bureaus also call for the laboratory label.

It might seem wise to suggest the careful reinspection periodically of station conditions and particularly of protective devices, but it is difficult to imagne a station management investing in fire prevention changes, only to allow speedy return to the bad conditions which were remedied. Where any such carelessness has been observed, it must be assigned to over-emphasis on direct insurance saving as against the more productive fire prevention idea, by some zealous fire insurance agent. The character of management looking so near-sightedly at such a vital factor in his plant operation, is rapidly losing caste with the financial interests supporting the electric light and power industry. The correct and increasingly popular attitude of power plant management toward fire prevention suggestions is one of earnest consideration. The high insurance rating today rather than arousing antagonistic feelings toward insurance companies, is impelling quick investigation and ready cooperation toward reduced fire hazard by the station operator.

The Characteristics of Flaming Arc Lamps.

(Contributed Exclusively to Southern Electrician.)

BY A. G. RAKESTRAW.

A Discussion of Operation, Illumination and Application Features.

The characteristic performance of the flaming or "luminous" arc lamp is due to the property possessed by some substances, of luminescence, which was described somewhat at length in a previous article by the writer dealing with illumination. Simply stated, it means that we get a greater amount of radiation than we would expect from a luminous body at the temperature corresponding to the electrical input. It may or may not be combined with selectivity, that is, the quality or the color of the radiation may correspond to its greater amount or otherwise.

Flaming arcs may be classified quite similarly to carbon arcs, either as regards the material used for the electrodes, or as regards the admission of air, or as regards the scheme of connections. The electrodes or "pencils" consist usually of a carbon rod containing a core of mineral salts which vaporize in the arc and totally change its characteristics. The quantity of light is greatly increased, the color changed, and the light instead of being emitted by the crater, is given forth by the arc itself, hence the name. The chemical used for the yellow light mostly seen in Calcium fluoride, while titanium salts give white, and other substances a pink light. Any change towards whiteness reduces efficiency, hence the yellow flamers are generally used. There is also a lamp using magnetite, an oxide of iron, enclosed in an iron tube, and termed the magnetite or "luminous arc." This lamp forms a class by itself and will be discussed in subsequent numbers.

As regards construction, flamers may be divided into two general types, the Bremer and the Blondel. The former of these, which is the earlier, has the two "carbons" inclined at an angle as shown in Fig. 1, the arc being deflected downward by a blow magnet, while the Blondel has them vertical as in the carbon arc. The two types are about equal in efficiency, but different in distribution, the Bremer type throwing the light nearly all in the lower hemisphere. As to construction, the vertical carbon lamp is much the simpler, requiring only a series or differential control, the same mechanism being used both for striking the arc and keeping it in adjustment. The inclined carbon lamp, on the other hand, requires not only blow magnets, but also a clock or sneak feed arrangement and a slipper block device to strike the arc. This type, however, has an advantage that much longer carbons and consequently greater life can be accomodated in a given length of casing.

The performance of the flaming arc is distinguished by

its high efficiency, which exceeds any other type of lamp, except some of the vapor lamps. The color given by the calcium electrodes mostly used, is a bright yellow, possessing a great penetrating power, and a cheerful, stimulating effect upon those working under it.

The flaming arcs are usually connected two in series on 110 volts, four on 220 volts, etc., altho now we have lamps for 110 volt multiple circuits, and for series and series-multiple operation. There is one concern that puts out a lamp operating three in series on 110 volts with 30

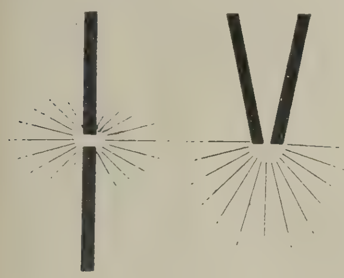


FIG.1

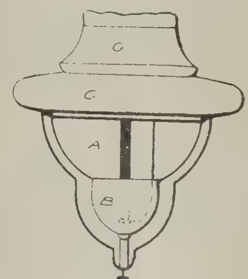


FIG.2

Fig. 1. Bremer and Blondel Types of Arcs.
Fig. 2. Enclosed Flaming Arc Using Special Form of Globe.

volts in the arc. The current is high, being 10 to 12 amperes. The life of the carbons is very short, most lamps being made in 10 hour and 17 hour sizes, using carbons 9 mm x 400 and 600 mm respectively. The 17 hour lamp is the best proposition as the first cost is not much greater and the carbons are less expensive proportionally and hence they are cheaper to trim. In fact the short life and expensive carbons have to a great extent, offset the advantages of higher efficiency, hence the principal changes and improvements which have been made have been largely to the end of securing longer life.

Some of the different means that have been tried for this purpose have been longer carbons, larger carbons, bridge core carbons, two sets burned consecutively, two sets burned simultaneously, and the use of enclosing globes. Of course there is a limit to the length of carbon which can be used without making the lamp too unwieldy, and it is necessary to keep the size down to secure the proper current density. The "Alba" lamp uses a vertical carbon having a rather large core of salts giving a white color. Another well known lamp has only one electrode containing chemicals, the other being plain carbon. In the "bridge core type, the carbon is flat and there are two cores, being connected by a narrow bridge hence the name, the arc travelling from one to the other. There are also lamps that use two pairs of carbons, cutting in the second automatically when the first pair is exhausted. By this means we can get a life of 20 to 34 hours, using the standard carbons. Furthermore the manufacturers claim that because the stubs can be completely used up, that a saving of $25.00 per year is possible with a lamp of this type.

Further experiments with a view of lengthening the life have resulted in the introduction of a lamp using for carbons, two positive and two negative, burned in multiple. The carbons are of the bridge-core type, the outer wall being carbon, and the central core and bridge of mineral salts. There are four carbon holders all connected to a common carrier, so that all four carbons move downward together. The two negative carbons are arranged in a

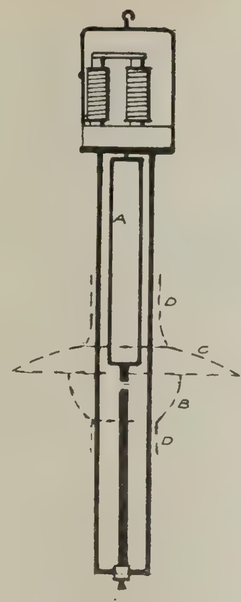


FIG.3

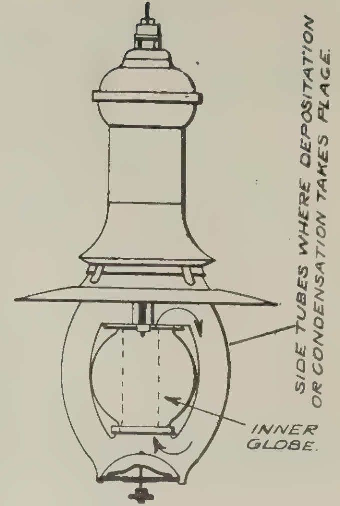


FIG.4

Fig. 3. Enclosed Flaming Arc. With A the Inner Globe, B Outer Globe, C Reflector and D Lamps Casing.
Fig. 4. Regenerative Flame Arc.

"V" shape, so that their ends meet at a fixed point in the arc chamber, which naturally prevents them from moving down further, as they come to a jam, and their position is thus self-sustained.

The positive carbons are arranged in a similar manner, being also self sustained. It will be observed that although there are four carbons in the lamp, they really become but a single positive and a single negative carbon in the arc chamber, and when operating, the lamp has but one arc burning and this arc travels back and forth from one carbon to the next, having a steady passage by means of the bridge core. As the carbon burns away, a sneak feed occurs by reason of gravity, and since this disintegration causes a very small movement at a time, the position of the arc is practically fixed. The two negative carbons are moved away from the positive ones by a slipper block actuated by the solenoids in the upper part of the lamp case. When the current is switched on, the arc starts immediately, and the series coils draw the carbons apart, their position while burning being regulated by the differential action of the shunt and series coils.

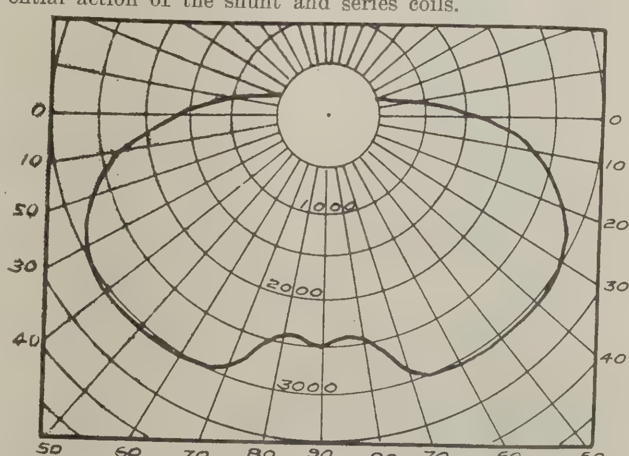


Fig. 5. Distribution of Flaming Arc With Vertical Carbons.

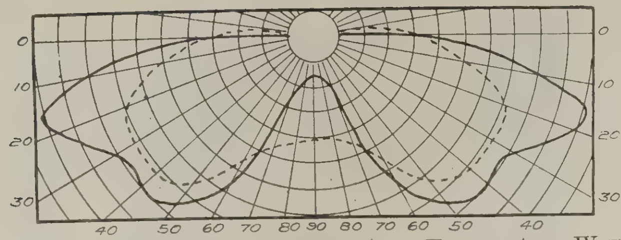


FIG. 6. DISTRIBUTION OF ENCLOSED FLAME ARC WITH VERTICAL CARBONS AND CLEAR AND OPAL GLOBES.

Another problem which has called for improvements in the flaming arc, is the disposition of the fumes given forth. The vaporization of the calcium fluoride produces fumes of hydrofluoric acid, a corrosive white powder, which floats in the air some little time before settling. It acts vigorously upon glass, being commercially used for glass etching. If it settles upon the lamp globe it quickly renders it opaque, and since the action is chemical, its effects cannot be removed. If it escapes in too large quantities into the air it might be damaging to merchandise and irritating to the lungs. However, with the usual conditions of installation, there is practically no complaint from this source. The problem is to prevent condensation on the lamp globes and this has been accomplished by producing a strong draft carrying the hot gases quickly away from the arc into a cooler chamber where the solids may be deposited.

The enclosed flamer, which is a rather recent production, was designed with the intention of increasing the life of the electrodes and we are now able to get from 50 to 150 hours life by this means. This result is accomplished by shutting out the air, and thus reducing the rate of oxidation. Since however, the vapors cannot leave the lamp, it is necessary to make special provision for the condensation referred to. Fig. 2 shows a flaming arc with a constriction in the globe immediately below the arc. The upper part of the globe is too hot to allow of condensation, but the lower part being somewhat shielded, receives the deposit. Fig. 3 shows another type of long-burning flamer, for which 150-200 hours is claimed. In this case there is a long narrow

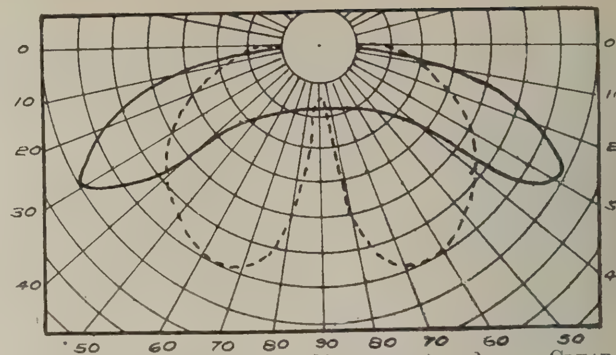


FIG. 7. DISTRIBUTION OF FLAMING ARC WITH CLEAR GLOBES AND WITH REFLECTOR.

inner globe as shown at "A". Fig. 4 shows what is called a regenerative arc lamp. There are two electrodes. The upper is ⅝ x 18 inches and is nearly pure carbon. The lower or positive one is ⅞ x 7 inches with a star shaped core of chemicals. The hot gases pass upwards from the arc, and return through side tubes as shown, where condensation takes place, and thence again through the arc, hence the name. Another advantage of this lamp is that since the arc can be made longer, the lamps can be run on 110 volt multiple circuits.

The Table I, gives some figures on the performance of flamers. These are average figures, compiled from the data given by several manufacturers, results of tests and other sources. Some lamps, no doubt may do a little better than this, but the idea is to present average results. Figures 6, 7 and 8, give distribution curves for the different types. From these the Bremer and Blondel types can be compared, also the effect of globes and reflectors.

As to the field of application of the flaming arc, it appears to be taking the decided pre-eminence for the illumination of large outdoor spaces, such as public squares, promenades, plazas, amusement parks, arenas, and outdoor performances and games of all kinds. It is also used for the spectacular illumination of business streets, either as a street lighting system or by merchants in front of their place of business. It has not been used much for general

TABLE 1. DATA ON PERFORMANCE OF FLAME ARCS.

Kind of Lamp.	Amp.	Volts		Watts	Candle Power		Watts per C. P.		Life	Size of carbons, and remarks
		Ext.	Arc.		Mean Sph.	Mean Hemi.	Sph.	Hemi.		
OPEN										
D. C., 2 on 110 volts, Bremer type*, opal globe	10	55	46	550	1460	1890	.45	.32	10** 17	9 m. m. x 400 m. m. 600 m. m
D. C., 2 on 110 volts, long burning, Bremer type	10	55	46–48	550	--------	3000¶	--------	--------	100	Bridge-core carbons, two pairs in parallel.
D. C., 110 volt mul., Blondel type, Alba globe	6.5	110	75	715	1129	2058	.63	.35	20	Upper ½" x 12" carbon. Lower ¾" x 11" Chemical.
D. C., series, Blondel type, Alba globe	6.6	78	75	510	1230	2051	.42	.25	--------	Upper ½" x 12" carbon. Lower ¾" x 11" chemical.
A. C., multiple, Bremer, light opal globe	12	55	42–45	500	875	1170	.52	.39	10 17	400 m. m. 600 m. m. x 9 m. m.
A. C., series, Blondel opal globe	‡4–7.5	50	42–45	494	875	1170	.50	.37	--------	Upper ½" x 12" carbon. Lower ¾" x 11" chemical.
ENCLOSED										
D. C., 2 on 110 volt Blondel type opal globe	10	55	45	550	--------	2500¶	--------	.22¶	100–150	Upper 5-8" x 10" chemical. Lower ½" x 10".
D. C., Regenerative 110 volt multiple, opal globe	5.5	110	70	605	706	1210	.80	.50	60	5-8" x 18" upper carbon. 7-8" x 7" lower chemical.
A. C., Regenerative 110 volt multiple, opal globe	7	110	70	525	583	875	.90	.60	50	5-8" x 18" upper carbon. 7-8" x 7" lower chemical.

*Also made for 3 on 110 volts—30 volts in the arc.
**20–34 hours life secured by using two pair.
¶Clear globe.
‡Using series transformers.

street illumination in this country, although it is largely so used abroad. One of the reasons for this seems to be that in order to take advantage of the enormous candle power of these lamps that they should be hung much higher and also further apart than is practicable in our American cities. One flaming arc will give as much light as six enclosed arcs, but it is not practical to replace even two or three enclosed arcs by one flamer, unless they could be hung from 50 to 75 ft. high, which is out of the question. It is evident that they will therefore only be used for general street illumination where the density of traffic warrants a high expenditure of watts per mile. There is no doubt but that a great many more would be used for business streets than at present, were it not for the quite rapid introduction of the ornamental post system using tungsten lamps.

For interior use, the flamer is used to some extent, especially in factories where the atmosphere is obscured by smoke or dust as it has excellent penetrating powers. It is also used for assembling shops, steel mills, or for outdoor use around factory or freight yards, where it can be hung high and the number of units necessary reduced. Its principal limitations appear to be its brilliancy, where small units are desirable, and its high first cost and high trimming expense. These shut it out of course of most inside work, except for such places as piers, warehouses, train sheds, exposition halls, and some other cases previously mentioned.

Conditions, Practice and Developments In English Central Stations.

(*Contributed Exclusively to* Southern Electrician.)

BY CECIL TOONE, AN ENGLISH ELECTRICAL ENGINEER.

Section 3b. Operating Conditions and Efficiencies.

The general evolution of the driving systems employed for central station auxiliaries has been the use of many small non-condensing steam engines (for the most part highly inefficient); the use of higher efficiency engines driving groups of auxiliaries through various rocking lears and spear rods and, finally, the use of electric motors, usually one per auxiliary, direct coupled or geared as required. That the latter system is best there can be no doubt the first method was terribly wasteful and by the second arrangement or by driving pumps from main engine through rocking levers, it often happens that the best speed of operation of the auxiliary cannot be approached and in any case the method is inflexible and cumbrous. It is difficult to give any generally applicable data as to the power required to drive the various auxiliaries of a central station plant but the following average data are drawn from working conditions in a number of English stations.

PERCENTAGES OF THE MAIN ENGINE OUTPUT.

Pumping water supply from well or river may require	½ to 4%
Driving Circulating Pumps (surface condensers) require	1 to 3%, say 2¼%
Driving Circulating Pumps (jet condensers) require	say 1%
Driving Air Pumps require	0.3 to 0.5%
Driving Forced Draught Fans for Cooling Towers, require	say 2½%
Lubricating Turbine and Generator Bearings require	say 0.15%

STEAM AND WATER PIPES.

The innumerable methods of arranging steam pipes may be broadly classified into those employing (1) Ring mains; (2) Duplicate single mains; (3) Single mains. The ring system certainly conduces to smooth steam supply at uniform pressure; affords a high factor of safety and localises breakdowns; and, in some cases, facilitates subsequent connection of additional boilers. Some fifteen years ago these mains were very popular but it is now generally considered that equal reliability can be secured at less capital cost by installing a liberally designed single range of piping. Suitable interconnecting branches and isolating valves are, however, very desirable. Overhead mains and descending branches are most common in England but mains laid in culverts beneath the flooring are often met with. Auxilary engines are generally supplied by a separate range of piping carrying anly saturated steam.

In the materials of construction, great changes have occurred during recent years. In place of the cast iron pipes, at one time so general, there are now to be found either: (1) Mild steel mains with riveted flanges and tees; (2) Solid drawn steel mains with cast steel tees and valves and screwed or riveted flanges; (3) Lap welded steel mains with welded or riveted flanges or tees (the requisite welding being often performed electrically). Up to 6 inch diameter mains, wrought steel flanges are frequently screwed on and brazed or the pipe may be expanded inside the flange after attaching the latter. Copper bends and branches are much less common than in the past and in turbine installations, several disastrous "strippings" have shown the advisability of placing wire sieves in the live steam mains to retain nuts, washers and so on. Pipes may drain to the engine separators which are suitably trapped and additional steam traps may be placed in the steam mains wherever required. From ½ to 3 inches of magnesia, micanite or sky diatomite or similar lagging is variously employed as necessary. Exhaust steam mains are usually of cast iron carried to the condensers or atmospheric exhaust shaft in chases beneath engine room floor. The atmispheric discharge shaft is carried up from 20 to 50 feet and is generally provided with a special "anti-rain" exhaust head to prevent nuisance to the neighborhood.

STEAM CONDITIONS PRESSURE, SUPERHEAT AND VACUUM.

Regarding the steam pressures usual in this country, some information has already been given in Section 2 on boilers. Among 87 typical English stations, the average steam pressure is 156 pounds per square inch (gauge),

the minimum being 95 pounds and the maximum 200 pounds. In seven representative turbine installations, the mean pressure was 170 pounds per square inch, the actual values ranging from 120 to 250 pounds. A usual result of running condensing is to reduce the initial pressure chosen by some 20 to 30 per cent. The greater the range of pressure from admission to exhaust, the higher the possible efficiency of the engine; the specific steam consumption of turbines decreases about ½ to ¾ per cent per 10 pounds per square inch increase in admission pressure.

It is now admitted that the chief advantage of superheating steam lies in the reduced cylinder condensation obtained the actual heat content per cubic foot of superheated steam is less than that of saturated steam. In reciprocating engines, the percentage saving effected per 1 degree Fah. superheat is greater for low than for high admission pressures and for non-condensing than for condensing engines. In any case the adoption of superheat is essential, to the realization of the highest possible efficiencies. The percentage reduction in steam consumption of reciprocating engines per 1 degree Fah. superheat ranges from 0.15 to 0.20 per cent, while the corresponding variation in the case of steam turbines ranges from 0.15 per cent for superheats of 25 degrees Fah. to 0.075 per cent for superheats of 100 degrees Fah. or more.

In 15 reciprocating engine installations and 8 turbine plants the average maximum and minimum superheats employed were as follows:

	Average.	Maximum.	Minimum.
Reciprocating	116°F.	200°F.	70°F.
Turbine	135°F.	240°F.	80°F.

Among the group of 170 stations, to which reference has already been made, about 30 per cent employ superheated and the remainder saturated steam. It is common arrangement to provide means whereby any desired mixture of superheated and saturated steam can be supplied to the pipe range at will.

High vacua are essential in all condensing plants to the realization of maximum efficiency but turbines are characterized by the extraordinary importance of specially high vacua. Whereas the percentage reduction in the steam consumption of a turbine is about 3¼ per cent on going from 25 to 26 inches vacuum, the corresponding reduction for vacua above 28 inches is at the rate of 6 to 7 per cent per inch reduction of back pressure. The importance of high vacua is greater for low than for high admission pressures and for saturated than for superheated steam.

Though vacua of 29 inches are quoted in various official tests on turbine plant, it is doubtful whether a lower back pressure than ¾ to 1 pound per square inch abs. (28-28½ inch vacuum) can be permanently ensured in a large commercial plant. Among twenty English central stations, picked at random, and including a few installations where turbines were wholly or partially employed, the average vacuum maintained was 26 inches, the highest being 29 inches and the lowest 23½ inches. At the present day there is no reason why vacua of 27 to 28 inches should not be maintained and this result is certainly secured in most large turbine installations.

According to Mr. Neilson's recent paper before the London I. E. E., the most efficient vacuum to maintain is as follows:

	Coal at $1.50 Per long ton.	Coal at $4.50 Per long ton.
In a 10% Load Factor Station....	26¼ in.	27 -27¼ in.
In a 20% Load Factor Station....	26¾ in.	27¼-27½ in.

Before leaving the question of vacua, it may be noted that the general method of citing results, as a vacuum of so many inches of mercury shows some tendency to give place to the more accurate expression within so many inches of the barometer. Were results always reduced to 30 inches barometer, the former method would be quite definite but unfortunately, this reduction is often not made and, worst of all, the point is often left in doubt. In view of the extreme importance of what may be termed the "last few inches of vacuum" in turbine installations, it is to be hoped that the method of direct reference to the barometer will soon become general. In the preceding paragraph 30 inches barometer has been assumed throughout.

THERMAL EFFICIENCY OF ENGINES.

The writer had hoped here to present a valuable summary of a large mass of engine and turbine test data now in his possession. Unfortunately, time has not permitted a satisfactory tabulation of this material the treatment of which is therefore postponed to Section 10 on costs. The question of steam consumption would, in any case have to be revived in that section hence the inclusion of the whole data therein will be permissible. Though the scientific expression of the thermal efficiency of any heat engine is by the B. T. U. absorbed per horsepower hour output, the older expression of results by the pounds steam per horsepower hour is still usual in commercial work. The latter method, of course, involves the statement of the steam pressure and temperature if the information is to have any precise meaning and, in any case, the basis of reference should be the brake horsepower hour and not the indicated horsepower hour. For electrical plant, the kilowatt hour is a convenient basis. Engines with specially good results per I. H. P. hour frequently give worse results per B. H. P. hour (which result alone affects the coal bill) than a cheaper engine showing much less favorably on the I. H. P. basis.

According as coal is cheap or money scarce, it may pay to sacrifice efficiency to low capital cost; this, however, is a purely commercial problem which will be again referred to in Section 10. A typical capitalized value of specific steam consumption is the $1,250 bonus or penalty, arranged with the makers of a certain 1,500 kw. Bellis set, for every pound per kilowatt hour below or above (respectively) 16¾ pounds at full load.

The desirable efficiency load characteristic of an engine obviously depends upon the use to which the latter is to be put. If the engine is to supply a constant load, it must have a sharply defined maximum efficiency at that load,

TABLE 6—EXAMPLES OF RECIPROCATING ENGINE EFFICIENCIES.

Engine.	Horse Power.	Lbs. Steam per Kw. Hr. (Full Load.)
Belliss	250	28 (cond.)
Coates	1000	22 (cond.)
Peache	500	27 (cond.)
Pollitt-Wigzell	200	36 (non-c.)
	500	23 (cond.)
	800	22 (cond.)
Willans	450	29 (non-c.)
		21 (cond.)

while, if the load is variable, the maximum efficiency may be somewhat sacrificed in favor of a high average efficiency over a wide load range. On traction loads, a high overload capacity at reasonable efficiency is imperative. A typical overload specification for such a case is 10 to 15 per cent for two or three hours; 20 to 30 per cent for ¼ to ½ hour and 40 to 50 per cent momentarily. Among some 30 English stations, the guaranteed overload capacity, for periods varying from 1 to 3 hours, varies from 10 to 50 per cent and averages 25 per cent.

Without offering the data contained as more than typical, Tables 6 and 7 may be here presented. Table 6 refers to various well known makes of reciprocating engines and Table 7 includes particulars of a few turbine units at present in operation in English stations. These data will be considerably amplified in Section 10. Very variable results are cited for exhaust turbine efficiencies; from 30-40 pounds steam, at about atmospheric inlet pressure, is usually consumed per kw. hour and 20 to 30 per cent increased output is obtained without additional steam consumption though the capital charges on the additional plant must of course be considered. The relation between the steam and coal consumption of any particular generating plant depends simply upon the calorific value of the coal and the efficiency of the steam raising plant employed and need not be specifically examined for the present.

TABLE 7—TYPICAL TURBINE UNITS IN ENGLISH CENTRAL STATIONS.

Station.	Unit Referred to		Lbs. per Kw. hr. at Fractions full Load					Steam Conditions.			Remaining Plant of Undertaking.	Total Kw. Cap. of Undertaking.
	Type	K. watts.	1.25	1	.75	.50	.25	Gauge Press.	Super. Deg. F.	Vac. Ins.		
Darlington	Belliss Impulse Exhaust.	550	----	----	----	----	----	Circa A. P.	----	28.5	Scott & Mountain; Belliss and Allen Reciprocating.	1900
Burslem	Belliss Mixed Pressure	600	----	(1)	----	----	----	----	----	----	One each, 100, 200 and 300 kw. Howden Reciprocating.	1250
Edinburgh	Rateau Exhaust	1200	----	(3)	----	----	----	Zero	----	27.3	Willans and Belliss Recip.	15200
West Ham	Willans-Parsons	1500	16.75	16.5	16.8	17.3	17.8	----	60	27.2	Ferranti & Willans Recip.	11100
Greewich	Rateau	5000	----	15.0	----	----	----	180	127	28.5	Musgrave Vert.-Horz. Recip. and 8 Willans Turbines.	34000
Motherwell (Clyde Valley)	Westinghouse Impulse	5000	13.24	13.00	13.6	14.8			140	28.25	Westinghouse-Parsons and Rateau Turbines.	
							18.4	175	175	28.75		19000
Manchester	Zoelly	6000	14.1	13.8	14.4	15.2	16.7	200	140	28	Yates-Thom, Wallsend, Willans Musgrave and Ferranti Recip. and Parsons Turbines.	45300
Newcastle Electric Supply Co.	Parsons	6250	----	11.8	12.0	12.4	----	190	190	29.1	Marine Triple Exp. Reciptg. Parsons, A. E. G. and Brown-Boveri Turbines.	67200

1Takes steam from 1400 kw. reciprocating engines; 30% greater output for same consumption; total costs per unit (excluding interest and depreciation), less by 6%.
2Turbine develops about same output as the sets which supply it with steam and saves 32% on cost per unit generated.
3Two 780 kw. reciprocating engines give 1200 kw. from one turbine.

MECHANICAL EFFICIENCY, HORSEPOWER PER KILOWATT.

The mechanical efficiency of modern reciprocating engines by good makers frequently exceeds 90 per cent on full load and that of turbines is, of course, considerably higher the only rubbing parts being now the main shaft bearings. Assuming an overall generator efficiency of 94 per cent, a quite reasonable value for modern machines. The overall mechanical efficiency of present day generating sets reaches 85 to 90 per cent for reciprocating and 92 to 93 per cent for turbine units. Authentic tests have shown 89 per cent overall efficiency for a 200 kw., 350 r. p. m. Belliss set at full load and, for a 600 kw., 125 r. p. m. McLaren set, 82 per cent at full load, 84½ per cent at ¾ load and 82 per cent at ½ load. As indicative of the huge inertia and low mechanical friction of turbo sets, an 1,800 kw. turbine rotor will run light for half an hour or more after steam supply is shut off. The theoretical ratio (100 per cent efficiency) between horsepower and kilowatts is approximately 1.340 and, assuming the above mechanical efficiencies, we have the following: Indicated H. P. required per kw. generator output in reciprocating sets varies from 1.58 to 1.49. Indicated H. P. required per kw. generator output in turbine sets varies from 1.46 to 1.44 and the brake H. P. required per kw. generator output in turbine or reciprocating sets is about 1.425. In small installations, the I. H. P. per kw. frequently rises to 1.7 or 1.8 but, in larger stations, the above values are very closely realized or even excelled.

Hydro-Electric Developments on New River.

General Manager H. W. Fuller of the Appalachian Power Company, Bluefield, West Virginia, was host to more than one hundred mine operators and others interested in the large application of power Wednesday June 19th on a trip to developments Nos. 2 and 4 of the company on the New River. Mr. Fuller and other representatives of the company lent their every effort to making the trip enjoyable. A special train was engaged leaving Bluefield early in the morning and returning in the evening. Guests outside of Bluefield were picked up en route to the dam sites. Individual menu cards bearing the Appalachian Power Company monogram were used for breakfast and luncheon. The dinner menu was in the form of a folder, the outside cover being black, setting off in contrast the white outline of the large sign of the Appalachian Power Company recently erected on the hill overlooking Bluefield. Sketched through the menu inside were the outlines of a high tension transmission line.

Representatives of the company personally conducted the party over the developments, making explanations and describing the work. It was announced that development No. 4 will be ready to furnish power August 1st and No. 2 October 1st, the former will have a capacity of 9,000 Kw. and the latter 20,000 Kw. A 36 page booklet giving the history of the company and containing photographs and statistics showing the progress of the work to date was given each guest as a souvenir. Besides Mr. Fuller the following representatives of the company were in the party: H. W. Buck, M. A. Viele, L. G. Gresham, B. W. Lynch, D. M. Bunn, A. Felio and H. E. Shed.

Economical Steam Generation in Central Station Plants.

(*Contributed to* Southern Electrician.)

BY GEO. H. GIBSON.

A Discussion of Conditions Favorable to Use of Economizer.

In the design of large steam power plants, such as central stations for electric light and power in the large cities, and power stations for electric traction systems, boiler surface is being considerably curtailed, while the efficiency of heat absorption is maintained or even improved by substituting the cheaper and more effective economizer surface. In addition there is a tendency towards higher and higher pressures, those around 200 lbs. per sq. inch being not uncommon in steam turbine plants. It is evident that any increase in the steam pressure, with accompanying increase in the boiler temperature, renders boiler surface correspondingly less efficient in the absorption of heat from the gases of combustion, since it reduces the available heat "head" causing the flow of heat from the gases to the water or steam. This leaves a greater duty to be performed by the economizer, and makes the latter corresponingly more profitable

Another factor in favor of the use of an economizer is the greater efficiency obtainable from auxiliary apparatus, such as boiler feed pumps, circulating pumps, fan engines, stoker engines, etc. The less the steam consumed by these appliances, the less exhaust there is available to heat the feed water in exhaust heaters, so that instead of obtaining 200° or even 210°F. with some exhaust to waste, it is not uncommon to find plants in which there is difficulty in maintaining a temperature of 160°F. in the water leaving the heater. Naturally the colder the water entering the economizer, the greater will be the activity of the surface in transmitting heat from the gases. A further factor of special importance in many plants is the large heat and water storage capacity of the economizer, giving it the ability to deliver large quantities of hot water in a short time, as when water is drawn from the boilers for filling dye or wash tubs, or when excessive drafts are made for steam for any purpose. While in the latter case the economizer does not supply the steam directly, it assists the boiler surface by supplying to it water upon which part of the work of steam making has already been performed, reducing thereby the proportion of work which must be performed by the boiler in transmitting heat to the water.

REDUCING COST OF GENERATING STEAM.

The cost of generating steam consists of two main elements, one the expense for fuel, and the other the expense for interest, depreciation, labor and other fixed charges upon the boiler, boiler setting, grate, draft apparatus and fittings. If the amount of boiler surface employed to develop a boiler horse power, that is to evaporate 30 lbs. of steam per hour, be increased, the amount of heat recovered from each pound of fuel will, within the limits of ordinary operation, also increase. That is, more heat will be absorbed, and the gases will be discharged to the stack and to atmosphere at a lower temperature as shown graphically in Fig. 1.

The curve is made up from temperature readings of the flue gases which have been taken in numerous boiler tests. The points shown by circles are the famous Delray tests made upon a Stirling Boiler by Prof. Jacobus. Likewise, the points shown in Fig. 6 have been obtained by dividing the square feet of economizer surface per boiler horse power by the number of hundreds of degrees difference between the initial temperature of the water entering the economizer and the initial temperature of the gases entering the economizer, and plotting the resulting figures against the million Btu's saved per square foot per 8760 hours, that is, a complete year. Both of these charts are therefore, plotted directly from observed data.

At the same time, however, that the cost of steam is being reduced by increasing the efficiency of heat absorption, the element of cost due to the fixed charges on the boiler and its appurtenances is rising. The rate at which heat is absorbed by any element of the boiler surface depends directly upon the difference between the temperature of the contents of the boiler, and the temperature of the gases of combustion in contact with that part of the boiler.

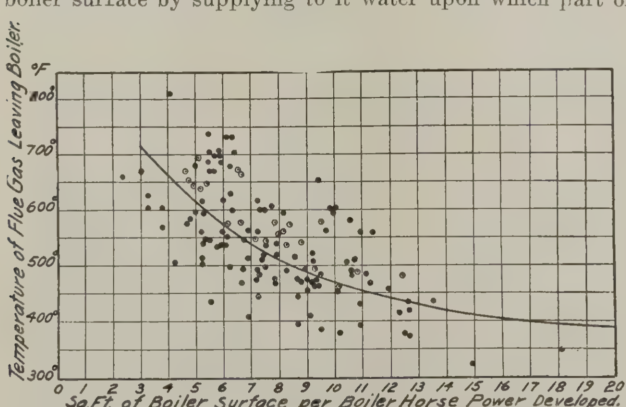


Fig. 1. Flue Gas Temperatures Corresponding to Different Rates of Driving.

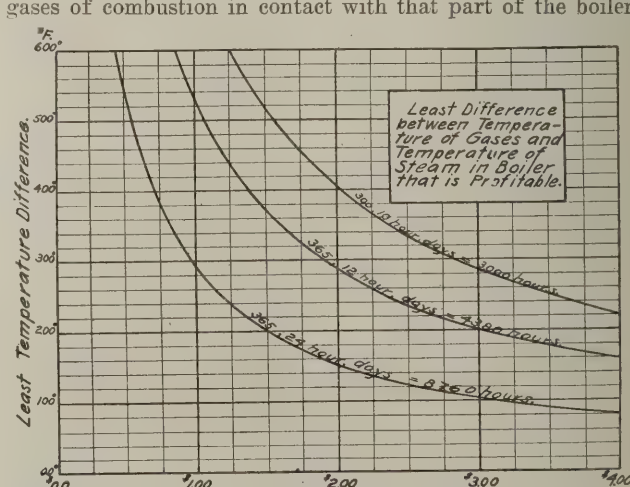


Fig. 2. Showing Point at Which Boiler Surface Ceases to Pay Profits.

If the amount of heat absorbed by that particular part of the boiler is worth more than the fixed charges corresponding, that particular element of heating surface is paying for itself, but as the temperature of the gases falls and approaches the temperature of the steam and water within the boiler, a point must soon be reached where the heat absorbed will no longer pay the fixed charges upon additional boiler surface. Just where this limit is will, of course, depend upon the price of fuel, the charges upon boiler surface and the proportion of the whole time that the boiler surface is being used. Referring to Fig. 2, it will be seen that for plants operating 10 hours per day, 300 days per year, and using $3.00 coal, the limit is reached when the gases are reduced to a temperature about 285°F., above the temperature of the steam.

If steam be assumed at 150 lbs. pressure gauge, which corresponds to a temperature of 366°F., it will be seen that the lowest temperature to which it will pay to reduce the flue gases under the above conditions is 650°F., showing by reference to Fig. 1 that it will not pay to put in more than 4 or 5 square feet of boiler heating surface per boiler horse power developed. However, as is at once apparent, considerable heat would be wasted under these conditions. If we assume a coal containing 14,000 B. t. u.'s per pound, burned with 26 lbs. of air per pound of coal, and the boiler room temperature at 70°F. the temperature in the fire will be about 2230°F., and if the same gases of combustion are discharged at 650 approximately 27 per cent of the total heat of the fuel will be lost in the chimney gases.

Feed water may have an initial temperature of anywhere from 50° or 60°F., in case the water is taken from a well or stream, up to 200° or 210°F., in the case of returns from heating and drying coils or water heated in an exhaust steam feed water heater. Taking water at 200°F., for instance, it will be seen that between such water and flue gases at a temperature of 650°F. there is a difference of 450°F. under which conditions the provision of additional heating surface would again become profitable. Under such conditions an advantage is secured in dividing the process of steam generation into two parts, one of which consists of heating the water up to the boiling point, and the other the evaporation or boiling of the water; that is, to apply the counter-current principle, which has proved most economical in heat transferring apparatus of all kinds. The boiler and economizer, connected as shown in Fig. 3, become in effect a counter-current apparatus for the transfer of heat from hot gases of cumbustion to water which is to be turned into steam.

The curves in Fig. 2, show the least difference between the temperature of the gases leaving the boiler and the temperature of the steam in the boiler that is profitable. In other words, if the difference in temperature is less than is shown on the chart, too much boiler surface has been installed for economy, and if it is greater, more boiler surface could be installed to advantage.

Assume that, S = the number of sq. ft. of boiler surface; A = the annual charge upon a sq. ft. of boiler surface; Y = the number of hours per year that the boiler surface is operated; Q = the number of heat units transmitted per hour; C = the cost of coal per ton; T_1 = the initial temperature of the gases of combustion; T_2 = the temperature of the gases of combusion as they leave the boiler; Tr = the temperature of the atmosphere; H = the number of thermal units per pound of coal; K_2 = the average rate of heat transmission in the last pass of the boiler; D = the lowest difference between the temperature of the gases of combustion and the boiler contents for which it is profitable to install boiler heating surface.

Then we have the equation, $SA/YQ + C/[(T_1 - T_2)]/T_1 - Tr]\ H\ 200 = A/DK_2Y$. The truth of this equation is easily seen. The first fraction in the left hand member is the cost of a heat unit absorbed by the boiler, considering fixed charges only. The second fraction is the cost of a heat unit considering fuel charges only. Now if we add another sq. ft. to an existing boiler, it must absorb enough heat to pay its own fixed charges, basing the value of the heat on the cost of heat as obtained from that part of the boiler already installed. Obviously we pass from profit to loss in adding additional surface when the cost of the heat from the additional surface is just equal to the cost of heat from the surface already installed. We may therefore increase the right hand member until the cost of heat obtained from the additional surface, which is the annual charges on sq. ft. of surface divided by the temperature difference at that point times the coefficient of transmission times the number of hours that the surface will be in operation is equal to the left hand member. The right hand member increases as D decreases.

Obviously the difficulty in solving this equation lies in finding the mathematical relations between the quantities

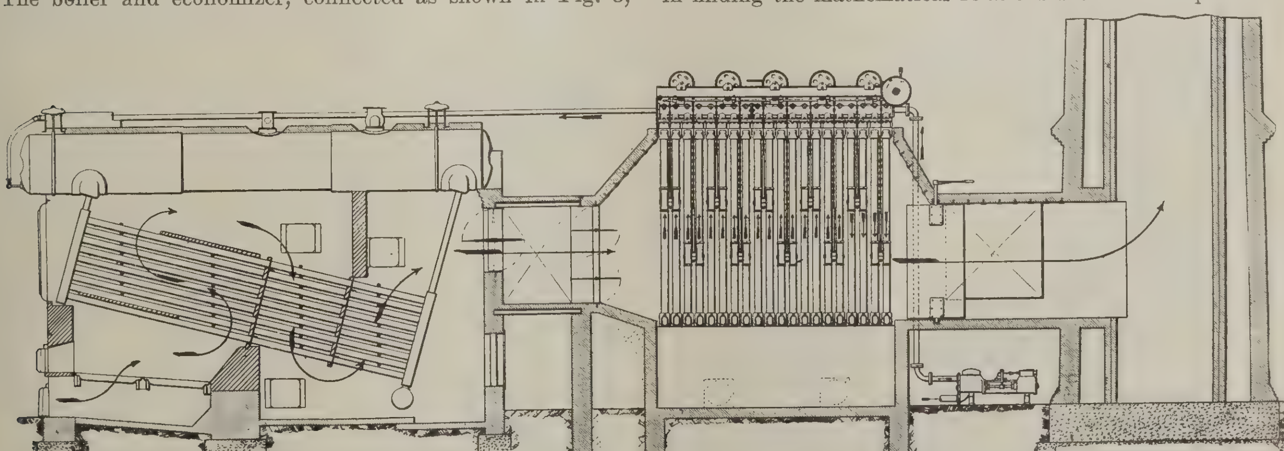


Fig. 3. The Counter-Current Principle in Steam Generation as Exemplified by Green's Economizer Installed in Connection With a Water Tube Boiler. The Cool Gases Serve to Heat The Cold Water While The Heated Water Absorbs Heat From The Hottest Gases.

S, K_2, Q, T_1 and T_2. Attempts to establish these relations from purely physical considerations have so far failed, because it is not known just how K_2 depends upon the difference in temperature between the contents of the boiler and the velocity of the gases, the absolute temperature, etc. However, in the case of commercial boilers, we can establish this relation by tabulating the results obtained in boiler tests, as has been done in the chart shown in Fig. 1 accompanying this article. If S be taken as the number of sq. ft. per boiler horse power developed, Q is the number of heat units per boiler horse power hour, namely 33,300. If we assume S equal to 5 sq. ft. T_2 is found from Fig. 1 to be about 550° F. T_1 is then H/.24G + Tr, if G is the number of pounds of gases of combustion per pound of fuel, in the present case assumed to be 26, while H has been taken as 14,500. For Tr we have chosen 70°, for A, 34 cents, and for K_2, 2½ B.t.u's. per sq. ft. per hour per degree difference.

As for A, we assume that the first cost of the boiler and setting is $15.00 per nominal boiler horse power, of 10 sq. ft. and of stoker, grate and draft apparatus, $5.00 per nominal horse power. The annual fixed charge represented by the interest on this investment and the amount that must be laid aside yearly to provide for the indefinite continuance of the plant, is taken on the basis of interest at 5 percent and sinking fund and maintenance charges at 12 per cent, giving a total annual expense, including fuel, of $3.40 per nominal boiler horse power, or 34 cents per sq. ft. K_2 we have taken as 2½ sq. ft. per hour per degree difference because that is a figure frequently assumed in calculating economizers and there is no reason why it should not hold for the conditions existing in the last pass of the boiler. It is true, that the coefficient of transmission is higher than this in the boiler as a whole, especially in those parts of the boiler which are in contact with gases at a much higher absolute temperature and at higher velocity and it is much higher in those parts of the boiler receiving heat by direct radiation from the fuel bed. However, we know of no reason for assuming that the heat transmission through boiler tubes is better than through economizer tubes, except as affected by the difference in diameter of the tubes, where all other conditions are equal.

This point has been pretty well thrashed out in connection with the Schulz Economizer, recently introduced in Germany. Inasmuch as economizer tubes are constantly scraped, there is no reason to assume that they will be more soot covered than boiler tubes, if indeed, so much so. The thickness of the iron has a practically negligable influence considering that the far greater part of the resistance to the transmission of heat is in the gas film outside the tube, compared with which, the resistance of iron is in considerable. In otherwords, there is a good reason for believing that given the same gas temperatures, and water temperatures and gas and water velocities, the difference between the performances of economizer tubes and boiler tubes would be very small.

In applying the formula given for Fig. 2, to the economizer surface, as in Fig. 4, we need only to insert in the second member the value of A for economizer surface. This is as much as saying that the limit for economizer surface is reached when each heat unit recovered by it costs just as much as it does when produced by the boiler. Of course, this is not quite exact in determining the most economical final temperature difference, since to do so, we should figure the cost of heat recovered by an additional sq. ft. of economizer surface against the cost of the heat recovered by all the preceeding surface, including both boiler and economizer. The difference, however, is not great enough to be worth taking into consideration for this purpose, especially as the theory indicates final temperature differences much lower than are ever attempted with natural draft. A for the economizer has been figured on the basis of a cost of $1.00 per sq. ft. installed and 12 per cent for interest depreciation, maintenance, power and attendance, making a total annual charge per sq. ft. of $1.20. With present prices, it would be more exact to take the cost of economizer surface at $1.20 per sq. ft.

USEFUL RANGE OF ECONOMIZER.

The economizer costs somewhat less than the boiler per square foot of heating surface, and the temperature difference at which it ceases to be profitable is therefore lower, as will be noted from Fig. 4. As an example, suppose that fuel costs $3.00 per ton and the plant is operated 300 days per year and 10 hours per day. It will be seen from Fig. 4. that the lowest economical temperature difference is about 110°F. If the initial temperature of the water entering the economizer is 200°, as just assumed, this will give as a final temperature to the flue gases of 310°F. which is still usually hot enough to produce sufficient draft with a good chimney.

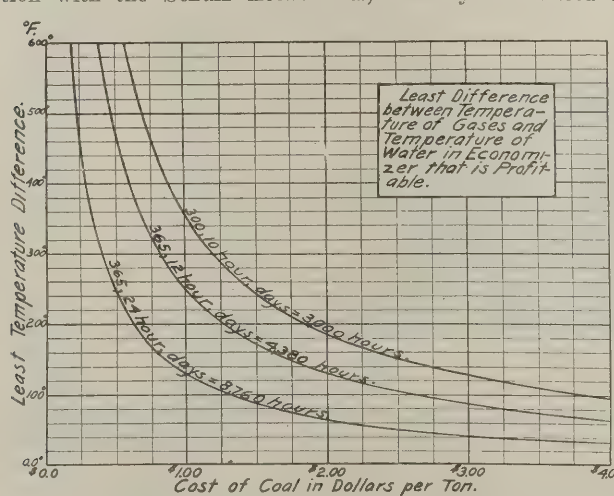


FIG. 4. SHOWING POINT WHERE ECONOMIZER SURFACE CEASES TO PAY DIVIDENDS FOR VARIOUS CONDITIONS.

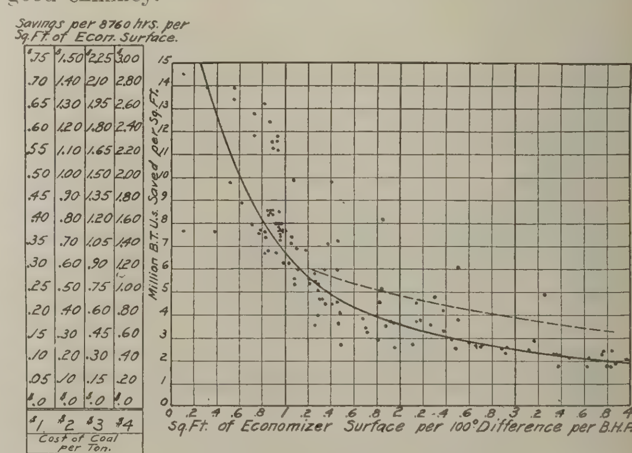


FIG. 5. YEARLY SAVING PER SQUARE FOOT ECONOMIZER SURFACE UNDER VARYING CONDITIONS.

FUEL SAVING FROM ECONOMIZERS.

The fuel saving to be expected from the installation of economizers may be estimated roughly at the rate of 1 per cent for each 10°F. through which the water is raised in temperature; or, in the average plant, 1 per cent for each 20°F., by which the temperature of the flue gases is reduced. In asmuch, however, as the determination of the number of degrees that the water will be heated or the gases reduced in temperature by an economizer of given sizes involves considerable calculation and some knowledge of economizer engineering, it is more convenient to use the chart presented in Fig. 5, which is based upon the actual results secured in some 200 plants where economizers have been installed. Suppose, for instance, that $3.00 coal is being used, as before, and that it is decided that the economizer should show a gross saving of 30 cents per square ft. per year. If the plant is operated 10 hours per day, 300 days per year, or 3,000 hours per year in all, it will be in operation only a little over one third of the time for which the chart has been made out, namely, 24 hours per day, 365 days per year, or 8,760 hours. Therefore to earn 30 cents per square foot for the year as a whole, a square foot of surface must earn at a rate of approximately 3 times as great, or 90 cents, on the basis of the time for which the chart is figured. Finding 90 cents in the $3.00 coal column, run horizontally until the curve is encountered, from which it is seen that 1.1 square foot of surface should be installed per boiler horse power developed, for each 100°F. difference between the temperature of the flue gases and the temperature of the water entering the economizer. Supposing as before that the former is 650°F. and the latter 200°F. giving a difference of 450°F., it will be seen that 5 square feet of economizer surface should be installed for each boiler horse power developed; that is, each 30 lbs. of water turned into steam per hour.

Evils of Low Power Factors and Means For Their Correction.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

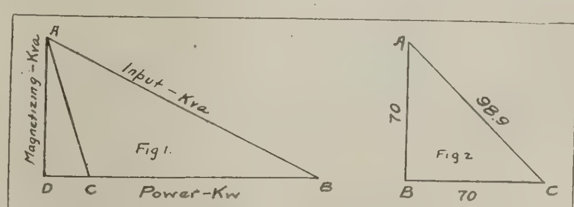
BY J. J. M'INTOSH.

IN alternating current systems loaded to a considerable extent with induction apparatus, the question of power factor becomes of vital importance. A low power factor on a system not only impairs the efficiency of the generating apparatus and distribution system, but it also seriously effects the regulation. Poor regulation on many of our most modern alternating current systems can be traced to low power factors. This fact was not realized until quite recently for, at one time central station managers gave little or no thought to this all-important question, it being considered strictly a technical question and of little or no practical value. This attitude has changed, however, when systems have become loaded with induction apparatus and the evils of low power factors became known with both generation and distribution. This is borne out by the fact that manufactures of electrical apparatus have received many inquiries regarding power factor correction. It is the purpose of this article therefore to briefly discuss low power factors and their correction by means of the synchronous motor and condenser, That this type of machine is fast becoming a very popular piece of apparatus for this work is shown by the large number of recent installations.

Power factor in alternating current circuits or apparatus is the ratio of electrical power in watts to the apparent power in voltamperes. All induction apparatus requires a magnetizing curernt. This current is practically wattless and is displaced 90 degrees in phase from the power component. As systems become loaded with transformers and induction motors the evils of low power factor caused by them become very troublesome. Transformers, when fully loaded, do not lower the power factor to a serious extent but when unloaded or only partially loaded their effects become serious and, as distribution transformers, generally speaking, are loaded only a few hours out of the twenty-four, it can be seen that they very materially lower the power factor. Induction motors require a magnetizing current also for their operation which is practically constant for all loads, its extent being fixed by the design of the motor. From this it is self-evident that induction motors have an extremely low power factor under light loads, and further more, that under no conditions of load can the power factor become unity.

This fact is illustrated very plainly in Fig. 1. DB is the power component and DA the wattless component. AB is the resultant of these two currents and is therefore the current drawn from the line by the motor. If the load on the motor is reduced, DB will of course be shortened and, with the motor running very light, DC would represent the power component, AC the current input while, the magnetizing current, DA will remain practically the same. From this it can easily be seen that a number of induction motors running partially loaded will very seriously affect the power factor on the system feeding them.

Modern transformers and alternating current generators are rated in Kva. (kilovolt-ampere) output. If the power factor on a system is unity, the apparatus will deliver its



FIGS. 1 AND 2. RELATION OF CURRENT INPUT TO POWER COMPONENT OF INDUCTION MOTOR.

rated load in kilowatts but, if the power factor is below unity the full energy capacity of the system cannot be realized. For example, assume the case of a 500 Kva. generator operating on a system at 0.60 power factor. The energy output would be only 300 kilowatts at full rated current output. This same holds true for transformers that

is a 100 Kva. transformer will deliver 100 kilowatts at unity power factor but at 0.60 power factor only 60 kilowatts can be obtained at full rated current output. As is shown in the above in any alternating current system having a low power factor a much greater current is being carried than is required for the real power consumption and, as the capacity of the distrubition system, generators, transformers and other apparatus is limited to the amount of current carried without injurious heating, it is easily seen that the full capacity of the system cannot be realized. As a wattless current is not an energy current, it does not register on the customers meter and is therefore, unproductive and a direct waste.

LOW POWER FACTOR AND REGULATION.

Another very troublesome evil of this lagging current, and one that is the cause of numerous complaints from customers, is its effects on the regulation. The regulation of transformers is inherently good at unity power factor but with a power factor of, say 0.70, the regulation would be between 3 and 4 per cent. Small lighting transformers operating at unity power factor have a regulation of from 1.5 to 2 per cent., but at 0.70 power factor the regulation would be only about 5 per cent. The regulation of alternating current generators is impaired to a much greater extent by lagging currents than transformers. The lagging current in the armature of a generator opposes the field flux, thereby tending to demagnetize the fields. The result is that at low power factor we have a correspondingly low armature voltage. To overcome this condition it is necessary to increase the exciter voltage and current. This not only increases the field heating of the alternator but calls for increased exciter capacity which means decreased efficiency. The regulation of the modern alternating current generator is usually within 8 percent. at unity power factor, whereas, with a power factor of 0.70 it is reduced to 25 or 30 per cent.

RELEASING CAPACITY OF STATION APPARATUS BY SYNCHRONOUS CONDENSER.

The seriousness of low power factor in a generating station is forcibly brought home to the engineer and manager when the apparatus in his plant has reached its limit in current, which obviously means its output, and of course the actual output in kilowatts may be far below the rated output, depending upon the nature of the load. For example, let it be assumed that a 5,000 kilowatt station is operating on a power factor of 0.70 per cent. This means that at full rated current output only 3,500 kilowatts can be delivered and that 30 per cent of the capacity is unavailable. Let it be furthermore assumed that the cost of the station, including all items is $120 per kilowatt. From this assumption 30 per cent of the whole investment or $180,000 is bringing in absolutely no return to the investor, while depreciation, taxes, etc., go on just the same. At 5 per cent interest this means a loss of $9,000 annually.

In the above case the engineer has two methods to pursue. The first, is the installation of additional generating apparatus, prime movers, and auxiliaries, which means a large expenditure, or, secondly, a synchronous motor (rotary condenser) must be installed. Looking at this question with the view of first cost, depreciation, maintenance, and labor, the latter method is generally to be preferred. One of the chief advantages of the synchronous motor, or rotary condenser, is its ability to operate at a power factor under the control of the operator, but this advantage is gained at the expense of the additional complication of an external direct-current excitation. The magnetic flux in this type of machine is at a constant value no matter what the exciting current may be and any condition not fulfilled by the direct-current excitation will cause either a lagging or leading armature current which will always give a constant magnetizing force, when combined with the field excitation. This characteristic of the synchronous motor makes it very useful for power factor correction, for, by properly adjusting the field that is, if the field is weakened the extra excitation required is provided by a lagging current which is drawn from the alternating current system feeding the motor, or increasing the field strength will decrease the lagging current drawn by the motor until a point is reached where the lagging current drops to zero. At this point the motor will be operating at unity power factor. If the field strength is increased still further a leading current will flow. By this means the motor can be made to neutralize the effects of either lagging or leading current on an alternating current system. In the case of an over-excited field the leading current which flows partially demagnetizes the field poles thereby maintains the proper value of magnetization. On the other hand if the motor is given a weak field the extra magnetization required is supplied by the lagging current drawn. Under this latter condition the action of the motor is similar to that of the induction motor.

The synchronous motor greatly resembles the revolving field alternator both in mechanical construction and appearance, in fact, an alternator and synchronous motor may be used interchangeably without any change being made in the windings. When so used, however, the service rendered will generally be unsatisfactory. An alternator should be designed so that any variation in the load will but slightly influence the terminal voltage. In order to meet this condition the armatures of alternators are generally designed to give a low armature reaction thereby rendering the demagnetizing effects on the field small. In the design of a synchronous motor, however, this condition is somewhat reversed, that is the motor should have a high armature reaction. It can easily be seen that with a low armature reactance, the current required when the motor is thrown on the line for starting would be excessive because the impedance of the armature circuits would naturally be low. Another point in favor of high armature reactance in the synchronous motor comes from the fact that should something happen to the field, that is, should it become weaken or broken, the magnetizing current drawn from the line would not be nearly so great as in the case of a motor with low armature reaction.

CONSIDERATIONS IN INSTALLING MACHINE.

When installing a machine for power factor correction there are several important conditions that ought to be considered. A condenser can be installed to drive a mechanical load without greatly lowering its efficiency as a generator of magnetizing current. When so used the power current of the load is in quadrature with the magnetizing current, therefore, the total current flowing is but slightly increased. Thus, in Fig. 2, if the wattless current AB be equal to 70 per cent of the rating of the machine and the energy current BC also 70 per cent AC, the resultant of these two currents, is found to be $\sqrt{70^2 + 70^2}$ or, 98.9 per cent.

The point of installation will also play an important

part as to the benefit derived from the condenser on a system with low power factor. For instance, if the machine is installed in the plant it will relieve the generating equipment of wattless current, but this will benefit the generating apparatus alone, because the wattless current will have to be carried through transformers and distribution system to the load. If the condenser is installed in the distribution system as nearly to the center of the inductive load as possible it will relieve the lines, transformers and generating equipment also. In some cases the inductive load on a system is so distributed that it will be found a matter of economy to install several small condensers at different points in the load in the place of one large one.

DETERMINING SIZE OF CONDENSERS.

The size of a condenser for any given conditions may be figured as in the following example. A certain system carrying a load of 600 kilowatts was operating at 0.65 power factor. The engineer in charge wished to raise the power factor to 0.9. Referring to Fig. 3, the power component of the load is shown 600 kw., and the apparent power component 923 Kva. The wattless component of the load must therefore be $\sqrt{923^2 - 600^2}$ or, 289 Kva. From this it is obvious that a condenser, to raise the power factor to 0.9 under the above conditions, must be of a size sufficient to supply the difference between 701 Kva. and 289 Kva. or, 412 Kva.

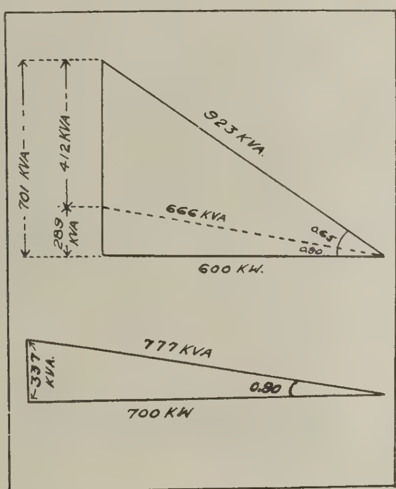


Fig. 3. Showing Increased Capacity of System by Use of Synchronous Condenser.

As a synchronous motor will carry a mechanical load without greatly lowering its efficiency as a generator of wattless current, it is very often used to preform both duties. If, in the case just discussed it was found desirable to carry a mechanical load equal to 100 kilowatts, and at the same time raise the power factor on the system to 0.9, the load on the system would then be raised from 600 to 700 Kw. The total apparent Kva. at 0.9 power factor would be 777 Kva. and the wattless component of the load 337 Kva. as is shown in lower part of Fig. 3. The motor under these conditions would, therefore, have to supply the difference between 701 and 337, or, 364 Kva. in leading wattless current. If, 364 Kva. is the wattless component of the motor load, and, 100 Kw. the energy component, the synchronous motor would have to be of sufficient capacity to carry $\sqrt{364^2 + 100^2}$ or, 377.4 Kva.

A standard line of synchronous condensers is on the market by a large manufacturer of electrical appartus. These machines are of light mechanical construction with comparatively high armature reaction constants and small air gaps. This lowers their cost and does not lower their efficiency as condensers. A standard line of machines of heavier construction is also carried for those cases where it is desired to carry a mechanical load.

When considering the installation of a condenser, it is interesting to note that in many cases the increased capacity of the line, due to the improved power factor, will, within itself pay for the apparatus. For example, consider a system working under the conditions illustrated in Fig. 3. Assuming the system to be three phase, the line voltage 2300, the length of the line to be only 2.5 miles, we find that at 0.65 power factor each conductor would require an area of 404,580 circular mils. At 0.90 power factor this area would be reduced to 248,265 circular mils per conductor, or, in other words, 19,118.5 pounds more copper will be required at 0.65 power factor than at 0.90 power factor. With copper at 16 cents per pound this means an outlay of $3,058.

STARTING FEATURES OF SYNCHRONOUS MACHINE.

The greatest drawback to a single-phase synchronous motor is that it is not self-starting and will have to be started by a starting motor or from some other external source. If the motor were connected to the line at standstill the current in its armature, which is rapidly reversing, would tend to turn the rotating element first in one direction and then in the other direction, the starting torque of a single-phase motor is therefore zero. In the polyphase synchronous motor a starting torque of sufficient strength is developed to bring the motor up to speed under no load. This is accounted for by the fact that as the current in one phase drops to zero value the hysteresis causes the magnetism induced by it in the poles to lag behind the current and this remnant magnetism is therefore acted upon by the incoming phase or phases thus producing sufficient torque, for starting. In order to increase the starting torque, the field of most of the latest type of machines are of some form of special construction. In some designs, to the pole faces are added copper bars which are connected on each end of the pole structure to rings, called short-circuiting rings. These rings completely surround the field. This type of construction not only assists in starting but also tends to prevent hunting, thereby making the machine more stable in its operations. This type of construction does not effect the efficiency of the machine when running.

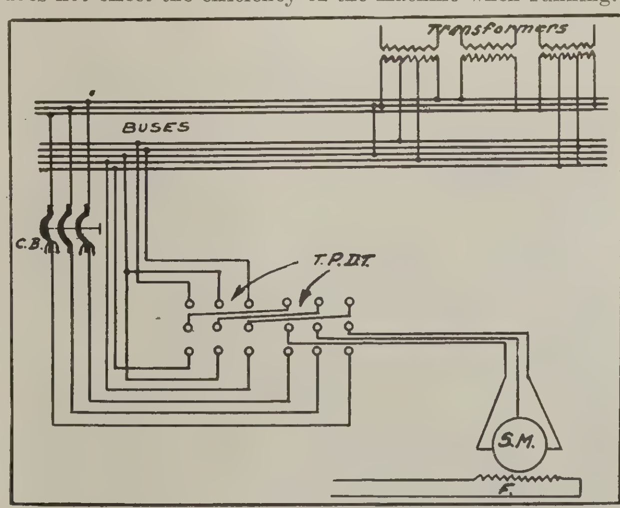


Fig. 4. One Method of Starting Synchronous Motor.

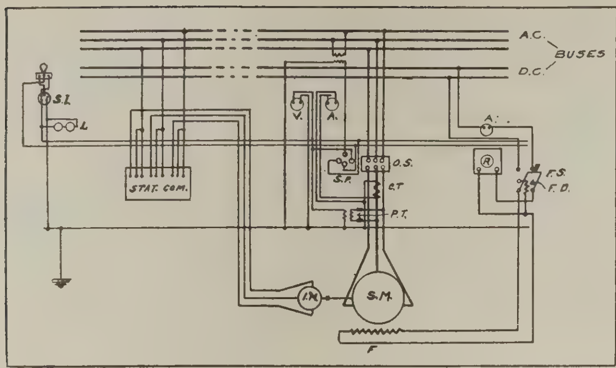


FIG. 5. SECOND METHOD OF STARTING BY USE OF STARTING MOTOR.

There are two methods in use for starting synchronous motors in practice. The first is by applying the alternating current directly to the windings of the motor, either through a compensator of from taps taken from transformers. Fig. 4 is a simple diagram of this latter method and one that is generally used for large machines. In this case two transformers are used for starting and three when running. The machine is started in three steps by the two triple-pole, double throw switches as shown. The circuit breakers are cut in on the third and last step. Several machines can be started in this way from one bank of transformers, one set of buses being common to all machines. Large machines started by this method require practically double full-load current. Small machines can be started by from 60 to 100 per cent full-load current by means of the compensator.

The second method of starting is by the use of a small starting motor which is usually of the induction type. The starting motor is either belted or connected directly to the motor shaft. The latter connection is generally to be preferred. In Fig. 5 is shown a simple diagram of connections for this latter method of starting. The current for the starting motor is drawn from the same buses as the current for the synchronous motor when running. In this case the motor must be cut in on the line exactly the same as an alternating current generator, that is the motor must be synchronized. Of the two methods of starting each has its advantages and disadvantages. In the first method a heavy current is drawn from the line in starting, which might prove very troublesome. If the motor were started and stopped infrequently this drawback might not be so serious. The chief advantage of this method of starting lies in the fact that the motor does not have to be synchronized with the system. In the second method a very small current is required for starting. Its chief disadvantage is that the motor must be synchronized which would require a more skillful attendant than the first method and might be otherwise objectionable. It is abvious that the first of these two methods cannot be applied to a single-phase motor. A polyphase synchronous motor that is self-starting is also self synchronizing, it being only necessary to give the motor its direct-current excitation after the motor has reached full speed.

A synchronous motor operates at maximum torque only when in synchronism with the system feeding it. If a condition should arise causing the motor to drop below synchronous speed, the motor would stop, because the torque developed below synchronism is not sufficient to enable it to carry load. From the above it is apparent that this type of machine is not adapted to work requiring variable speed conditions, no independent speed regulation being possible. In conclusion it may be said that a low power factor uses up the capacity of both distribution system and generating apparatus as poor regulation, therefore poor service, results. As has been shown the synchronous motor is admirably adapted for power factor correction, and, although many engineers consider it somewhat complicated and at times involving many possibilities of accident, it will in all probability play very important part in commercial work in the future.

Features in Design of a 30,000 K. W. Central Station.

BY IRVING E. MOULTROP, CONSULTING ENGINEER FOR EDISON ELECTRIC ILLUMINATING CO., OF BOSTON.

Section 3. Station Switching Arrangements.

THE switching arrangements for a large station are very important and deserve the same careful consideration that is given to any other part of the station. A few years ago common practice was to install this switching in the engine or turbine room along one wall and on perhaps one or more galleries. To a large extent this is the practice to-day. A few of the larger central stations have realized that this was not the best arrangement and are now installing their switching apparatus in either a separate room or in a separate building. In my opinion the most desirable arrangement is to install the switching in an adjoining room provided with observation windows so that the switchboard attendant can, if desired, oversee the turbine room.

For high tension alternating current the one great requirement in a switch house is ample space. When necessary it is possible to crowd the apparatus in the boiler room or turbine room without seriously affecting operation or taking chances on the continuity of service, but it is the worst possible mistake to attempt anything of this sort in the switch house. Dry air is one of the best dielectrics known to the art to-day, and it is likewise one of the cheapest. If the apparatus is crowded, no matter how carefully it is insulated or equipped with suitable barriers, there is bound to be a weak spot somewhere in the insulation which sooner or later under some emergency will break down. When a breakdown of this sort occurs on high potential systems it is very difficult to predict how far it will go and how much damage it will cause. It is safe to say, however, that the results are bound to be far more disastrous than anybody would expect.

The arrangement of the apparatus in the switch house

should be just as simple as possible. Every connection should be direct and be in the open where it can be seen and inspected. At the same time all high tension apparatus should be in rooms with locked doors, and all persons except those having business there should be kept out. Of course, all apparatus in these high tension rooms will be insulated in the best possible manner, but in addition there should be sufficient guards and barriers to keep a person from accidently coming in contact with the insulation. The static discharge from such insulation is not only very disagreeable but may be dangerous.

It goes without saying that switches and other movable apparatus should be remote-controlled, and all the control apparatus should be grouped in a central point so that the operator has all of his controlling apparatus, instruments, etc., in a very compact space immediately under his hand and eye. I want to especially emphasize the importance of simplicity in the switch house. The electrical operator has a position akin to that of a combined train despatcher and signal man of a big railroad terminal with this difference: The trnsmission lines, etc., to be operated will usually be greater in number than the tracks the train despatcher is handling, and the electrical operator has no dummy track layout in front of him to show him just what is taking place. The electrical operator has to think just as quickly as the train despatcher and a mistake will be nearly as serious. A great many engineers think that it is not well to put the electrical operator in a separate room from the one containing the prime movers; the argument being that those in charge of each room have to work in close harmony with one another and have to keep in touch with one another's movements. Experience has proved that the separate room is no handicap. With an efficient and positive signal system or means of communication between the two rooms, it has been shown by experience that there is a lesser liability of mistakes occurring when the switching is in a separate room, and there is no appreciable loss of time in transmitting orders between the two rooms. Any communicating system between these rooms must be simple, positive, quick of action and so designed that in case a mistake is made the communicating system itself will show who is at fault. The marine ship telegraph system that is used on boats throughout the world is most admirably adapted to perform this service.

We will pass now to the coal storage field which, I will assume, is located adjacent to the station building. This should be of ample size for several reasons; first, the station under consideration is bound to grow and the coal requirements are very apt to increase beyond the original expectations. Furthermore, there are bound to be times when it is desirable by reason of threatened labor troubles or by a very favorable price to put in a large supply of fuel, although under normal conditions I think it is advisable not to store coal very long. The storage capacity of the size which I have indicated is so large that it is hardly feasible to house it in, and I believe the most practicable way is to store the coal in the open and directly on the ground. Coal loses a certain amount of its B. t. u. value by being stored in the open, and for this reason it is not desirable to store it for too long periods of time. It goes without saying ,that this coal should be handled by machinery throughout. The conveying apparatus which takes the coal from the boats or cars, as the case may be, should be of very liberal capacity, so that the boats or cars may be emptied in the shortest possible time without being delayed on account of the capacity of the conveying machinery not being sufficient. No matter what system of storage is adopted provision should be made so that a portion of the coal in any part of the pile can be rehandled or removed with reasonable rapidity. Soft coal when stored is bound to heat to a certain degree, the degree of heat depending on the constituents of the coal itself, but any storage yard must be carefully watched for heating, and the best way I know of to treat this trouble is to move that coal into the boiler house and burn it under the boilers before the heating has become excessive. It goes without saying that no coal should be put into the storage yards that cannot be reached by the reclaiming machinery. The conveying machinery connecting the storage yard with the bunkers in the boiler house can be of very much smaller capacity than that conveying the coal to the yard; for the reason that the coal is burned in much smaller quantities and at a fairly uniform rate. This machine must be as rugged and free from breakdowns as it is possible to obtain, and that supplying the boiler house should always be installed in duplicate. The best of coal handling machinery will break down at times, and it would be very awkward, if not impossible, to keep the boiler room of a large power plant supplied with coal without the use of conveying machinery.

We have now covered the general features of the design of a large central station in a very hasty manner and I wish to make a few general suggestions. In selecting apparatus do not let the first cost be the sole determining factor. Good machinery is never cheap, and cheap machinery may require annual repairs to an amount far in excess of the difference in the fixed charges.

When you have a problem of this kind in hand make as many preliminary designs of the arrangement of the station as you can possibly think of. A careful study of one design will bring out ideas which are likely to be improvements; and any design, besides having a number of good points, will be open to some objections. It is one of the problems of the engineer to reduce these objections to a minimum. The manufacturers of the various pieces of apparatus to be installed always have good ideas on the method of installing them, and my experience has been that all reputable manufacturers are very glad to advise their customers. Always discuss these station designs in detail with the people who are going to operate the station. The advice from a good operating man should always be obtained. He knows better what his problems and difficulties are than anyone else. Under no consideration would I omit consulting with the operating man. It will probably mean that you will have to make a number of additional studies before you find the best means of meeting the various criticisms of the proposed design. This is sometimes discouraging, but it always pays. I have in mind a problem of my own, where over twenty-five different studies were made before a satisfactory solution was found, but the time spent was well worth while. It costs very little to build stations on paper; it costs a lot to actually construct stations. Besides this, every dollar spent is a direct charge on the capital of the company. A simple mistake in design not detected on paper may be the cause of spending a good many thousand dollars to rectify it, and the operating department will have to pay dividends on the cost of rectifying this mistake as long as the station is in existence.

Convention of Ohio Electric Association.

As this issue of Southern Electrician goes to press the Ohio Electric Light Association is in convention at Cedar Point, Ohio. The Ohio Association is the largest electrical association other than the N. E. L. A. and represents the electric light and power companies other than municipal in the state of Ohio. The preparations for this convention have been extensive and the business program made to include three morning sessions and one afternoon session with plenty of entertainment between. A display of exhibits for manufacturers has been arranged for and many companies are taking advantage of this opportunity to bring the merits of particular devices to the attention of the Ohio members and guests.

The order of business at the convention is as follows: On Tuesday July 16, president W. C. Anderson, Canton Electric Co., delivers his address. This is followed by reports of the secretary and treasurer and committee on electrical transmission, by M. H. Wagner, of the Dayton Power and Light Co., Dayton, Ohio, chairman. At the Wednesday morning session Hon. Halford Erickson, chairman Railroad Commission of Wisconsin, will present a paper on rate making. Secretary D. L. Gaskill will also give a paper on the public vs. the utility. A report of the committee follows next by T. D. Lyon, Union Gas and Electric Co., Cinn. The third session will be held on Thursday morning and the report of committee on meters given by John Gilmartin, Toledo Railway and Light Co., Toledo, Chairman, and a paper on electrolytic purification of sewerage by Prof. F. C. Caldwell of Ohio State University, Columbus. At this session election of officers will be held. At the last session, Friday morning, J. C. Matthien, Dayton, Power and Light Co., Dayton, will read a paper on supply of electrical current to rural districts. A paper will also be presented on joint pole line construction by J. L. Spore, Toledo Railway and Light Co.

Printed copies of all papers have been mailed in advance of convention so that discussions could be prepared on them and papers will be read in convention by title only, the time of sessions being devoted to a discussion of the subject. This is a feature which other sections can profitably adopt.

Convention of Illuminating Engineering Society.

The sixth annual convention of the Illuminating Engineering Society will be held at the Hotel Clifton, Niagara Falls, Ontario, September 16 to 19. An excellent program of papers has been arranged for, many representing the results of recent photic investigations. Further details will be announced later.

Convention of National Electrical Contractors Association.

The twelfth annual convention of the National Electrical Contractors Association is now in session as this issue goes to press. The meeting is held this year at Denver, Colorado and from the extensive arrangements made for it by the association and the electrical trade of Denver there is every indication that the event will be one of importance in the life of the organization.

At the open session of July 17th at 10 a. m. there will be three addresses that will be of interest to the entire trade. Governor John F. Shafroth will speak on "The Resources of Colorado;" Mr. Maurice B. Bisco, president of the Denver Chapter of the American Institute of Architects, on "The Architect and the Contractor," and Mr. Alva F. Traver, superintendent of the Denver Gas and Electric Co., on "The Relation of the Central Station to the Contractor." There will be three business sessions, so as to allow ample time to thoroughly discuss the work of the organization, and arrangements have been made to have these meetings addressed by representatives of other branches of the electrical industry.

On the 17th, a seeing Denver trip will be made and on the 18th the Colorado Electric Club gives a luncheon to all attending the meeting. The annual dinner takes place during the evening followed by a vaudeville performance. July 19th is given up to a trip over Moffatt Road the wonderful scenery of which cannot be described.

The present president of the national organization, M. L. Barnes, of Troy, N. Y., has served two years as president and been identified with the association since its organization in 1901. To him must be credited a large part in its great strides during the past two years which is strongly evidenced by the fact that the membership has nearly doubled.

Wrightsville Beach Rejuvenation.

The activity that placed North Carolina on the Jovian map last October when 53 new members were added at one time, is still spreading. In January, 17 others fell in line under the same leadership, that of statesmen W. P. Bear and L. L. Ledwell operating with Charlotte as a center. In the early part of February, statesman N. L. Walker, president of the Carolina Electrical Company rallied a live force of 16 more recruits at Raleigh and at Wrightsville Beach, July 6, he brought again under his standard 12 others. The features connected with this rejuvenation were of such a character that the order has made a deep impression on the section and especially those who were present for it was strictly typical of the highest ideals that the order stands for.

The Rejuvenation held on July 6th, was preceded by a three day outing, a number of Jovians and a few candidates arrived on the morning of the Fourth and attended the atheletic events, boat racing, etc. During the morning of the fifth the party went fishing. At 8 o'clock Friday

NICHOLAS LEWIS WALKER, No. 2950, STATESMAN FOR NORTH CAROLINA.

evening the Jovians were given a souvenir dance by the Tidewater Power Co. Manager Skelding and Superintendent Hunt of the company took the party to Wilmington on special cars Saturday morning. After passing through the residential sections, the first stop was made at Tidewater Power Company's large and well equipped shops, which were inspected. From the shops a trip by trolley landed the party at the new Power Plant, in which special large turbines have just been installed. From the power plant the Jovians were taken to the Cape Fear Club and served with refreshments.

The Rejuvenation began at 8 o'clock Saturday evening when the twelve candidates were shown the mystics of Jovianism. Following this came a Joviation and clam bake at the seashore. Statesman N. L. Walker acted as toastmaster, and the keynote speech was made by Mr. Chas. N. Evans, president of the Southern National Bank, of Wilmington, his subject being "Co-operation between the Banker and the Electrical Man." Mr. Evans gave the jovians a very hearty welcome to Wilmington and to Wrightsville Beach, advising that the mayors of both places, the former being his winter home, and the latter his summer home, had turned over their keys to "The men who started the wheels of the world turning faster than they had before electricity was known." Mr Evans was followed by Bros. Julien Binford, Jr., Past Statesman of Virginia, T. W. Denison, A. Brill, Sam Goldback, R. H. Westbrook, W. T. Jones and J. O. Brock. Sunday was spent very quietly and peacefully, sleeping, resting and bathing.

Convention of Georgia Section N. E. L. A. at Tybee Island, August 15, 16 and 17.

In the July issue, the plans for the coming convention of the Georgia Section were briefly outlined. At the time this issue reaches our readers the event will be about two weeks off and yet time to arrange for attendance. The organization has been very active in furnishing information as to the meeting place and general plans through numerous circular letters and post cards so that it will not be necessary to explain the nature of the meeting. Suffice is to say in this connection that this, the second meeting of the section will be worth while from a business standpoint to every central station from the highest official down to the line men and station engineers. The day is past in the central station field that a managment can attend to its own affairs exclusively and render an average service either to its customers or financially to itself. New ideas and business getting methods are daily changing and the fact that one public service company does something that another does not, spreads from community to community like wild fire. Consequently a general unfavorable public opinion toward the backward company. This convention therefore presents the opportunity to get out and learn first hand what the other companies are doing that you are not. The convention is to be known as a working convention although there will be ample opportunity for recreation, there being planned a sailing trip, a trip to Fort Screven, one to the new plant of the Savannah Electric Co., and over the old race course. It will be worth while to spend the three days at Tybee.

President William Rawson Collier, general contract agent of the Georgia Railway and Power Co., of Atlanta advises that the headquarters will be at the New Hotel Tybee, Tybee Island and that reservations for rooms should be made early. Special summer rates can be secured to the island and arrangement should be made with local railroad agents.

The chairman of the program committee, Mr. J. S. Bleecker, manager Columbus Railroad Co., reports that the program for the convention will be as follows: Thursday a. m. August 15, registration. At 2 p. m. the first session will be called to order and the welcoming address and that of president given. These addresses will be followed by the report of committee on membership and finance. Two papers will be read at this session, one on Electric Vehicles in the Southeastern States by A. N. Bentley, of Electric Storage Battery Co., and the other on Synchronous Condenser by H. E. Bussey, Resident Engineer of General Electric Co. In the evening a boat ride will be enjoyed on the Atlantic.

At the Friday morning session the following papers will be presented and discussed. "A Mechanical Collector, its Offenses and Defenses," by Thos. W. Peters, Commercial Agent, Columbus Railroad Co. "Arc Lamps and the more Recent Developments Thereof" by L. A. S. Wood, Westinghouse Electric and Mfg. Co. "Buying Coal on a Btu. Basis by M. L. Sperry, Manager Savannah Electric Co. The afternoon of Friday will be taken up with a visit to Fort Screven. An evening session will be held on Friday at which a paper will be presented on Electric Rates by G. S. Merrill, Asst to Chief Engineer of National Electric Lamp Association. The report of the Public Policy Committee will be given by P. S. Arkwright, President Georgia Railway and Power Co.

At the session held Saturday morning a paper on Diversity Factor will be read by W. L. Southwell, Commercial Engineer of Central Georgia Power Co. After the discussion on this subject the convention will go into executive session when various reports of committees will be read and the election of officers held. On Saturday afternoon an automobile ride around the Grand Prize Race Course will take place and a visit made to the new power station of Savannah Electric Co. The program committee extends a cordial welcome to wives of delegates and other ladies who attend the convention and promises an enjoyable time.

Brighter Pueblo, Colo.

On the evening of June 22, the white way system recently installed on main Street in Pueblo, Colo., was lighted for the first time. Forty six clusters of five light standards with globes projecting upward makes up the system which will be known as the "Duke White Way" of Pueblo, in honor of T. A. Duke commissioner of lighting.

The program attendant upon the opening of the new ornament lighting system started with a concert at Third and Main streets by the Santa Fe Trail band. T. A. Duke, commissioner of lighting officially lighted the system.

The system cost approxiamtely $5,000. The property owners paid the cost of installation, being assessed at the rate of $2 per front foot, while the city pays the cost of maintenance. This, it is estimated, will be less than the old style. The Arkansas Valley Railway, Light and Power company operated by the H. M. Byllesby Co., of Chicago, has the contract for lighting and also had the contract for installing the system.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

The Central Station and Its Commercial Department.

Why should a central station have an organized commercial department? What are its proper functions? What are its relations to the company and to the public? What is the most effective form of organization? What amount of system is necessary and what should it cost to get new business? These are some of the fundamental questions on which we invite suggestions and discussions in future numbers of SOUTHERN ELECTRICIAN. There is hardly a central station employe who comes into contact with the public but whose experiences and opinions along some of these lines will help to make this department of value. While not entering into a detailed discussion of all these points, we present here a few thoughts to serve as a basis for future topics.

We believe that every central station should have a commercial department. It need not in every instance be separately organized, but in every central station organization there should be at least one person in authority whose training has been along commercial lines, that is, who is experienced in dealing with the public. Even the largest sales or commercial departments are no more than this, a body of men trained to meet the public. We further believe that this function cannot, without loss, be combined with or subordinated to, the operating or accounting departments or the general management. While no doubt, in the very smallest companies, it may be necessary for the commercial representative to assume some other duties to occupy his time, yet every corporation serving a community of 5,000 inhabitants or over should have enough possibilities for expansion to keep at least one trained solicitor engaged.

The commercial manager and his assistants must be able to look at things from the customers standpoint. The general manager cannot do this, for he had the matters of operation, construction and frequently the purchasing to take care of and he cannot give commercial matters the attention they deserve. Neither has he the time to dig up new business, and hunt up new uses for his product. It is now an established fact that the best interests of every concern demand separate administration of the producing and the selling ends of the business.

As already stated it is still more unsatisfactory to have the clerical, accounting, or bookkeeping staff, attempt to perform the commercial function. The attitude of clerks and collectors in general towards the bill-paying public is only too well known. Even where the company takes pains to select courteous employees, we know that the man behind the lattice work is really in no position to know the customers feelings or his needs. Neither can the man who reads the meters, or who installs them, or who runs services, or in fact any of the operating force know in a proper way these feelings and needs. No one unless trained to it through experience in going out and getting new business, can know just what is necessary to get and keep the good will of a customer. There is really no necessity, even in a small company, of shearing a solicitor of all authority, for that would be the same as making a contracting agent out of the general manager. It would be better to pay a solicitor a little more and get one who can be entrusted with a little authority, sufficient to enable him to adjust ordinary matters on his own judgment.

It is often asked if a commercial department should be required to affirm and sustain its position as a producing factor in the organization of the company. Our answer to this question is without a question, yes. It is further logical to ask how one can be sure of this. How can natural growth be distinguished from stimulated growth and how can the selling end of the business be systematized? There is much to be said along these lines. Up to the present time there has been but little done in the way of systematizing the sale of electricity, there is too much left to chance and guess work. For a commercial department to justify its existance, there must be an advance in the matter of systematic management, every detail must be carefully worked out.

It must be remembered in this connection, that the attitude of the public is an important factor. The public, upon whom it is depended for the disposition of the product, and upon whose good-will or bad-will the future of the business may depend, in too many cases has a disposition to regard all public service corporations with suspicion. Can there be a more fruitful field for thought, than the ways commercial and new business organizations may be used to secure and keep the good will of the public in general and of customers in particular? Evidently this cannot be reduced to dollars and cents, nor measured in Kw. increase in connected load. But it is essential that it be borne in mind, and special efforts directed towards its accomplishment.

Internal organization and system are important. There should be just enough of each to answer the purpose and not so much as to become cumbersome and retard the proper work of the department. Certain records are absolutely necessary, others are of doubtful value and still others are a clear waste of time and effort. We shall hope to go into these matters more fully as the discussions develop and bring out the points involved.

Electric Appliance Campaigns.

In the May issue we discussed the general question of residence business, with special reference to wiring campaigns and we were told in an interesting way, how results have been secured. Naturally, most of the persons contracting for electric service for residences, do so for lighting purposes and yet there are a number of other uses to which it may be put. The central station should take advantage of this fact, as far as it may be instrumental in increasing the current out-put or the connected load. The use of any current consuming device may be of benefit to the central station in any or all of three different ways.

First, it is evident that any new use for current will popularize electric service to just the extent that it is introduced. If any operation can be more easily performed

by electricity than in any other way, central station customers should know of it, and if the appliance is an article of universal application, a great convenience and popular in price, it is therefore a means of securing and retaining customers and often the means of inducing the new customer to install wiring for devices as well as for the electric light. We should hear therefore of persons securing the current in order that they may use an iron, washer, or vacuum cleaner, the use of the current for light being incidental.

Second, a benefit is secured through the income from the current consumed. With some devices this is negligible, with others large. Most household devices are not used during the hours that the lights are in use, that is, the consumption is "off-peak" and while the kilowatt hours consumed are paid for at the regular rate on account of being demanded at periods of light load, the cost to the company is much less. To put it another way, such demand tends to improve the load factor of the plant, or the ratio of the kilowatt output to the 24-hour capacity. Of course, if the demand created by appliances became so great that the plant capacity were determined by the appliance load rather than the lighting load, the situation would be entirely changed.

Third, a benefit may be derived from a profit on the sale. The question of whether or not, the central station should sell at a profit, was thoroughly discussed in the April number of this year, with the concensus of opinion being that appliances should be sold at the full retail price. However, while the profit from the sale of the appliance should be realized, it is not in any case the most important advantage to be derived. In most cases the profit from the sale will scarcely cover the expenses of making it if it does that.

To form a load of maximum value to the central station, appliances must be of such a nature as to be of general use, popular in price, durable and a good current consumer. Such a device is the electric iron. The advantages of ironing by electricity are too well known to mention, convenience, cleanliness, freedom from heat, and saving in time are the principal ones. On account of these advantages, proper advertising and solicitation has shown that a great majority of electric light customers can be induced to use irons. Toasters, percolators, hot plates, etc., are also often made the subject of successful summer campaigns. Most campaigns for such devices carry a free trial, or deferred payment offer in connection, with the natural result that with ordinary methods of placing that a certain number will not be retained. Irons, toasters, and hotplates have the advantage that considerable periods of use have but little effect upon their looks. With percolators, chafing dishes, and the like the case is different, as a little carelessness may spoil their looks entirely, and care must be exercised in this direction when planning a campaign with the free trial inducements.

Appliances in large numbers are always placed as a result of special campaigns. One reason for this lies in the fact that all domestic heating appliances are seasonable in their application, that is, the best results in introducing are brought about by concerted effort during the period of the first warm weather, and it is always wise to consider this feature. This department contains in this issue some accounts of successful campaigns with the methods used and the results secured. We solicit letters telling of such campaigns at all times. A. G. RAKESTRAW.

SUGGESTIONS FROM READERS.

R. B. Mateer, Consulting Electrical Engineer for Denver Gas and Electric Light Co., Denver, Colo., on Profitable Appliance Campaigns.

In what follows the writer has mentioned a few of the campaigns that have proven of more or less interest to his central station both in the number of the appliances sold, as well as the educational effect resulting in the electric appliances becoming a necessity and not a luxury. Last year the representatives were provided with a rig on an average of one to each territory per week. Each left the office in the morning loaded up with irons and called on a well selected list of consumers to whom he had previously sent a personal letter advising of his call on that date. Each representative per week placed an average of 50 irons per day, out on trial, the trial period lasting from 10 to 30 days depending upon the customer and his or her characteristics. This intensive educational campaign covering a period of 90 days and results showed an average of 1,000 irons per month sold at such prices as to result in a reasonable profit to the central station. Also additional inquiries were received such as resulted in a considerable number of sales during the winter months.

Electric toasters of the G. E. type, have been placed on trial for a limited period only, the same means being used to cover territory. Within a period of three months 1,000 toasters have been placed in use yielding a profit to the company from the sale and resulting in a desire for even a higher priced appliance. Many combination toasters of Westinghouse type are now sold each month as the result of the activity and popularization of this appliance by means of a limited trial period.

Percolators, mostly of the El Perco type, have been placed in a neat easily handled case and in a month's period of time without specialization over 100 were placed in use. This was accomplished as a result of house to house canvas and in connection with the daily routine work of the representative.

Eight-inch fans, handy for the residence, have found much favor and while many were sold last year to date the sales have exceeded that of the preceding year. A trite statement printed on the gas bill, an attractive folder treating on fans and mailed to the home is an introduction that often paves the way for the representative to close the business.

Electric curling irons! What hotel or modern apartment house is complete without a wall socket suitable for attaching the plug of a curling iron? Who among the fair sex desires to heat an iron over the top of a smoky lamp or who desires to climb up on a chair to light a gas jet, sometimes singeing those precious locks? As a result of an educational campaign amongst the architects the modern apartment houses, the well designed residences not especially the expensive types, but also the moderate priced structures, are equipped with floor outlets for reading lamps, with a floor receptacle in the kitchen and plug or receptacle in the bath room, not to mention the receptacle in the dressing room where the fair lady may stand and curl her hair and note the trtistic effect in a good glass. Personal letters to a selected list of prospects resulted in sales to 80% of those receiving the letters and whose fate it was to reside in apartments with wiring arranged for the use of this appliance.

G. R. Trumbull, Commercial Manager Meridian Light and Railway Company, Meridian, Miss., on the Best Devices for Securing a Uniform Load.

The ambition of the manager of every central station is a uniform load and to operate as nearly as possible all of his generators 24 hours daily at their maximum capacity. The prospects of realizing such an ambition depends, of course, entirely on local manufacturing and industrial conditions, as well as, the activity of his commercial department. To operate during the day with a uniform load and no valleys, except at meal hours, can be brought about largely with one class of new business, and that is the installation of motors for power purposes. It is true, there are other forms of new business to be secured which will aid materially in building up the day load, but nothing is quite so profitable as the power business.

In small and medium sized properties where the Commercial Department is not composed of specialists, every effort should be made to teach some one of the salesmen to become an expert power salesman, and he should be allowed to devote all of his time, or as much as is necessary to the sale and installation of motors. One fifty horse power motor running 10 hours daily is worth considerable more to a central station than 1,000 electrical heating devices.

Central station business, except motor service, is influenced more or less by the different seasons and fluctuates accordingly. The summer time offers great opportunity for the installation of refrigerating plants in hotels, restaurants and storage warehouses. The latter, particularly, can be interested, as they handle great quantities of perishable goods. When the heavy lighting load falls off in the spring, special campaigns on the sale of fans and irons will prove most successful and profitable. Careful analysis shows that the electric iron consumes 100 per cent more current that any other small device.

It is quite as necessary to hold the load as high as possible after the peak, as this is a period when greater profits are derived from the sale of current. Electric signs, decorative and show window lighting are the best class of business for this time, providing, of course, they are placed on the flat rate basis from dusk to midnight. The electric vehicle has proven to be good market also. The fact that the demand comes during the night hours, proves this business very profitable.

Central stations should practice what they preach along all these lines, and become the leaders in exploiting such appliances. Theirs should be just a little the biggest and brightest sign ,and the show windows likewise. Also they should have faith in the electric vehicle by operating as many as possible. There are many more methods of upbuilding the off-peak load and all should receive their share of consideration. Nothing is too small or too large, if we would reach that goal we are all striving for.

Ad. Schemes That Have Pulled Business in Atlanta, Ga.

As an example of an advertisement that has proven its pulling power, we reproduce herewith one used by General Contract Agent Rawson Collier of the Georgia Railway and Power Co., of Atlanta. This "ad" appeared, occupying a full page, in a Sunday edition and on Monday 150 electric fans were rented. Last year by similar advertising schemes 356 fans were placed in service in a very short time. Mr. Collier is a firm believer in publicity of all

An Ad that Rented 150 Fans in One Day in Atlanta, Ga.

kinds, stuffers in bills, educational phamphlets, and a liberal amount of newspaper advertising of a nature to boost the electrical business generally. Due to the reduction in size of the "ad" below, the copy is illegible, and we reproduce herewith the type matter at the right and left of the central figure as an illustration of the kind of copy which Mr. Collier realizes excellent results from and which is after all, through its educational nature a type of copy that makes for accumulative results rather than speculative. It has never been the policy of the contract department in Atlanta to push electrical devices through special campaigns yet through consistent advertising and general publicity along the lines mentioned and shown here, a very considerable number of fans, irons and other current consuming devices have been connected.

You May Buy a Fan Or Rent One The Season For $3.00

The observant housekeeper takes a hint from the business man and makes hot days in the home perfectly comfortable by using the electric fan.

You couldn't induce the woman who enjoyed the fan's never failing breeze last year to do without it this year. She finds it indispensable in almost every department of her daily routine—in the boudoir while dressing, in the library, the dining room, the kitchen, the living room and on the front porch evenings or afternoons. The beauty of the electric fan of today is the fact that it is portable; may be moved from one place to another by merely removing the wire cord as you would remove an ordinary incandescent bulb and attaching it to the socket in the room desired.

There Are Two Sizes For Residences: The 8-Inch and the 12-inch

The demands of the up-to-date housekeeper are exactly met in the eight-inch type of fan—a fan designed expressly for home use. It runs without noise, and is so economical that it will run all afternoon at the cost of one cent. For those who have very large rooms or want a stronger breeze there is another type—the twelve-inch, six-blade residence fan—also noiseless and costing only a trifle more to operate.

Every wired house should have one or the other. They may be purchased outright from any good electrical firm, or the Georgia Railway and Power Company will rent one of the eight-inch type from May until November for $3.00.

Phone the contract department, Main 4945, and have one sent out immediately. The hot season is now on.

At the present time Mr. Collier is trying out in a small way the possibilities of the Ozonator. He has several installed in leading sanitariums, hospitals, department stores and offices and is of the opinion that they are to be favorably received. They represent a small load but will have a long hour use.

Every new business manager is anxious to adopt those schemes that make for good feeling between customer and station and there is no question but that better results can be obtained by new business activity where such a feeling exists. There are many personal touches that can be effectively applied by the new business man worked out in his own way that will pay for the time and trouble. With the permission of Mr. Collier, we present here the substance of a letter, which he writes to each new customer and personally signs. The appreciative reply to this letter is not rare and never but in most cordial terms. In this form or a modification, it can be profitably used to establish relations of a counter nature to those that may be suggested by a communication in the form of a bill for service when same, for any reason, has not come up to expectation.

Dear Sir:

We note with pleasure that you are a customer of this company through your order to our contract department dated June 27th.

We trust that your relations with us will be both pleasant and profitable to you and to this end, the contract department has been instructed to extend to you all available facilities of good service. This service includes prompt attention to your requests for assistance in case of trouble anywhere in the service we furnish, and we trust that you will notify the contract department whenever their assistance is desired.

Simply call Bell 'Phone 4945.

GEORGIA RAILWAY & POWER CO.

Contract Agent.

100 Electric Irons Sold in One Day. Results of Campaign by Robert C. Leonard, New Business Manager Oklahoma Gas and Electric Co., Oklahoma City, Okla.

It recently seemed expedient to our general commercial manager to ship us 100 electric irons and instruct us to get them on our lines in whatever way seemed advisable. Since we maintain no supply department and furthermore desired to do nothing which would antagonize the six supply dealers who are already handling the iron business very satisfactorily, we were slightly puzzled as to just what course to take. Finally the following plan was laid and carried out.

Arrangements were made with the dealers to take the irons on consignment at our cost and sell them for one day only at a price which represented a reasonable profit to them but was a greatly reduced figure for the consumer. We agreed to devote our regular space of 30 inches to one issue of each of our three daily papers to advertising this sale and in addition, to mail out to our resident consumers, a large number of postal cards upon which had been printed a cut of the iron and the guarantee and terms of the sale. We left it to the discretion of the individual dealers as to how and how much each was to advertise this sale. Each one however put in a nice window display, some ran newspaper ads, while others ran slides at the picture shows.

Each dealer was delivered a sufficient number of irons to make a good window display and the remaining irons

A POST CARD THAT SOLD 100 IRONS IN ONE DAY AT OKLAHOMA CITY, OKLA.

were held available for delivery as they should be needed. It was the understanding with the dealers that after our supply was exhausted any dealer who was sold out, should have access to the stock any other dealer might have on hand. Our supply was exhausted by 9 a. m., on the day of the sale and by noon the entire stock was almost gone. The entire hundred irons were sold before the day was over. We were particularly gratified over the result of this sale because we believed the town to be already fairly well stocked with irons.

Thomas W. Peters, Commercial Agent, Columbus Railroad Company, Columbus, Ga., on Status of New Business in Columbus.

The writer regrets that he does not have time at present to go into details regarding his ideas in reference to the general functions and policies of the commercial department and campaigns for increasing the revenue to central stations. There is one thing I have found however, which I believe can be pursued by every central station man, and that is, have one rate and stick to it, making no exceptions. Of course it may be necessary to have several classifications of minimum charges to take care of the different kinds of business, but I believe that it is possible for a company to have a rate which can meet all practical conditions. This rate will of course depend upon local conditions and competitive business. You understand when I say "one rate," that of course the power and lighting rate will be different. We have in Columbus, I believe about the simplest rate that it is possible to get and we have made no exceptions to this rate in signing up any of our customers. The fact that we have no special rates and that each customer is treated alike, I believe has made it possible for us to secure the amount of business we have. When I tell you that in the business section of the town we have secured on our advertising rate, practically 90 per cent of the stores for some class of electrical advertising it may surprise you, it is however a fact.

As regards the campaigns for business we have only pursued one policy "get-at-itiveness" and "stick-to-itiveness." The result in one class of sales namely, power, has made it possible for us to lead in the sale of motors in the South-eastern States for the first six months of this year. This information has been given to me by one of the leading electrical manufacturers.

When we first started our campaign in January for power business we believed that we were turning almost every wheel in Columbus that it was possible to turn by electricity, but every once in awhile we run across some one who has never thought it possible to use central station

power in their field. We have just changed over a steam laundry from steam drive to individual electric drive, also supplanting entirely gasoline for heating purposes and saving our customer approximately $5.00 per month net, after allowing a certain amount for interest and depreciation and payment on his motors. The customer in question was so well pleased that he asked me, the other day, if it was possible for him to do away with his coal entirely, that is substitute an electric heated boiler for his steam boiler.

An interesting thing happened with this customer, after we secured for him a new fireman to take place of his old fireman, who said he could not keep steam up in his boilers unless he had a heavy fire. The new fireman is keeping steam up in the boilers with a very light fire and is also taking care of his horses and wagons, and the customer claims that the fireman has more than saved him his wages in the wear and tear on the wagons and saving of fuel, due to the better attention received by the horses. You can readily see that although horses cannot be charged up to power still this item should at least be credited to the amount of money saved by putting in electricity.

In regard to our scheme for getting washer-women to use electricity it simply amounted to charging them a higher rate for current than our present rate. We contracted with one of the electric concerns in Columbus to wire a certain number of houses for three lights, we supplying the washerwoman with irons and necessary lamps in addition to the work done by the contractor. On this class of service we used a prepay meter, with a 15 cent instead of the regular 10 cent gear charging them $1.50 minimum instead of the regular $1.00. The difference of 5 cents per kilowatt hour being the amount credited to the wiring account of these customers. We found that after so long a time that practically 60 per cent of these customers were not using their irons due to the fact that the 15 cent rate made it a pretty expensive proposition for ironing, they were using electric lights and were very much pelased with them. We believe if we had used a 12 cent rate in place of the 15 cent rate that we would have had considerably more success than what we have had.

COMMENTS ON LAST MONTH'S DISCUSSION ON RATES.

Last month we published a very interesting rate discussion by Mr. F. P. Wood of the Arkansas Valley Railway, Light and Power Co., which brought out clearly the advantages and disadvantages of the systems in use. From a commercial standpoint we have but one criticism to make. After discussing the eight classifications of rates, Mr. Wood says, "Assuming now that the Hopkinson method is the most logical, an attempt will be made to develop the subject along that line," which he proceeds very clearly to do. Our criticism lies in this, that the assumption that this rate is the most logical is very far from establishing the fact that it is the most commercially successful, because there are other considerations to be taken into account.

We give it as our opinion that no one rate, however scientific or logical, will develop to the utmost all of the lines of business open to the central station. Each line must be studied, and a rate offered which, while being as equitable as possible, has features which will attract this class of business. We particularly welcome a discussion along this line and trust that all will feel free to give their opinions. In this and the folowing number we take up some points in connection with the functions and internal organization of commercial departments, solicitation methods, etc., which should also bring up points for discussion. EDITOR NEW BUSINESS DEPT.

B. W. Mendenhall, Commercial Agent, Utah Light and Railway Company, Salt Lake City, Comments on Rate Discussion in July Issue.

I have read the article in the July issue entitled "The Influence of Rates and Service on the Extension of Business" and this article is, in my opinion, a very good summary of the relation of rates to commercial development. It is so good, in fact, that I am loath to call attention to a few of the points made in which my opinion differs somewhat from the writer's, as these points are minor and naturally subject to differences of opinion.

The general theory of an equitable rate has been pretty well established now through decisions of commissions and through practice of central stations. I think perhaps the Doherty Rate comes as near representing the generally accepted theoretically equitable rate as any proposed. It is my opinion, however, that the three charges, namely: the consumer, the capacity, and the energy charges, make the rate rather too complicated for commercial application, and in adopting our own rates we have attempted to accomplish the result aimed at in making a separate consumer and capacity charge by combining these two into a graded capacity charge, depending upon the consumer's maximum demand. We think this accomplishes the same result, and at the same time simplifies the rate.

Analysis of the rates in use by any particular central station will show that these rates are a result of a gradual development. We started out originally with flat rates, which were soon followed by uniform meter rates. These were followed by graded flat rates and meter rates, depending upon the quantity used, and finally differential rates were introduced, varying with the consumer's load factor. Few central stations have found themselves in a position to change completely over from one system of rates to the other at any particular time, and in order to put into effect the more equitable systems of charging as the theory and practice of rates has been developed, countless variations of these four general schemes have been introduced.

I can hardly agree with the statement of the writer in the latter part of the first paragraph, commencing on page 314, that the "Doherty and Hopkinson rates are not attractive business getters." Our experience with the Doherty rate, modified as before stated, is that it has been a very effective business getter, especially in view of the fact that we have keen gas competition, as it has enabled us to win back practically all of the long-hour burners, especially the smaller customers who had adopted gas under our older schedule of graded meter charges, depending upon the quantity. In accordance with the writer's suggestion, we offer this as an optional rate, and under these circumstances we have little difficulty in getting our customers to understand it. If we had attempted to force it upon them they would refuse to understand it.

Referring to the writer's item two, we believe that central stations are not justified in making a lower rate for small power customers, say up to two horse-power, than for lighting, as we believe this business can best be handled by connecting such single-phase motors to the consumer's

lighting service and meter, thus having a single meter and service connection. It is our observation that the use of small motors of this class is intermittent and that the factor is as low as the lighting load factor, and that the value of the service rendered is so great in comparison with the cost that few customers will object to paying the regular lighting rate for it. For this reason, we maintain the same rate for light and for power up to a gross bill of \$10.00 on our regular block lighting rate. On our optional load factor lighting rate we desregard the demand of such motors in fixing the consumer's capacity charge.

Referring to item three, as previously stated we grade both the fixed or capacity charge and the current charge, thus taking care of the consumer's charge and the Doherty rate and also the quantity discount.

Referring to item five, the analysis of our expenses leads us to conclude that there are overhead charges even on off-peak customers, since the company must maintain the customer's account, his meter, and adequate transformer installation, service wires, and in many cases heavier secondary and primary distribution systems in the vicinity of this customer in order to be prepared to supply him, and that this expense constitutes an overhead charge whether the consumer uses the power off-peak or on the peak. In our off-peak rates, therefore, we discount the fixed, or capacity charge sixty per cent and apply the same current charge.

We are inclined to believe that it would be a dangerous policy to install flat rate service in a residence for electric flat-irons, principally because this would introduce a strong temptation to the consumer to utilize other appliances, including lighting, from this service, very much to the company's loss. Our experience demonstrates that such a rate is not necessary; owing to the great convenience and superiority of electric ironing, consumers, in this locality at least, are quite willing to pay the regular meter rates for this service. We have sold 10,000 irons on our lines and are confident that the supply dealers have sold half as many more with a population of 125,000 people served.

R. B. Mateer, Consulting Electrical Engineer, for The Denver Gas and Electric Light Co., Denver, Colo., Comments on Rates and Rate Making as Presented in the July Issue.

The question of rates, the determination of equitable methods of charging and the flexibility of such rates so far as additional business is concerned, is one that has aroused considerable discussion not alone at N. E. L. A. sessions but amongst various companies operated in a syndicate, also amongst the various departments of companies themselves. There seems to be no doubt but that a fair and equitable basis of charge is desired but the fairness of such a system so far as the public is concerned is dependent principally upon the returns that it is desired to make to stockholders and upon the economy or extravagance of the management of a company. Some companies are operated under the management of those who quibble at the small outlets and make no attempt to check the large leaks be it a syndicate composed of many or an individual property. Too often have political activities, unnecessary advertising by reason of attempts to subsidize newspapers, resulted in the maintenance of rates that certainly could not be considered fair. The only solution for this is the absolute elimination of a central station as a factor in the politics of the future and then it is possible to arrive at a just, equitable and reasonable charge for the product which today is not a luxury but has passed through the various stages until it has become a necessity. Barring further discussion on the political situation so far as central station is concerned it might be well to call attention to the fact that where good service is given to the consumer the question of rates seldom enters into consideration. The central station is more like a first-class store that specializes on the best that money can buy, comparing the best article to the best service and therefore not exacting but receiving their price without quibble. So I would again reiterate that it is not the price per kilowatt that is of prime importance but the service given by the quasi public corporation.

The commercial manager of today who gives little or no attention to the character of the service supplied by his company and who is therefore unable to adjust many complaints offhand without reference to the investigating bureaus, is one of the past and shortly will yield his place to the commercial engineer, dignified, if you choose, by the title of manager, the man who is an electrical engineer of some experience and who has had an opportunity to develop the commercial side.

It is true that the matter of rates should come under the jurisdiction of a commercial manager but it is also true that unless vested with almost executive authority those who are desirous of carrying favor with political parties or others will attempt to make rates of their own to the detriment of the business-getting ability of a commercial manager. Assuredly therefore should a company of the quasi public utility corporation type, confer with its new business or sales manager and arrive at a base of charge such as will possess the flexibility desired by the sales manager when he so earnestly seeks to promote new business.

Various methods of charge have been proposed by many who have given this subject some consideration. The great majority of those discussed in the July issue of Southern Electrician are of little or no value and are in a way merely the reminders of early attempts to charge for electric current. The only ones today that are still considered as worth while are the following: "A" A straight meter rate with a proscribed minimum based upon the installation. "B" Optional rate of a service charge, a demand charge and an energy charge. "C" Flat rates for a window, sign and general exterior display, of course, based upon a certain number of hours burning and where such an installation is purely within the control of the central station it provides those who will place the display in commission and at the proposed time discontinues same.

Experience is a wise teacher and it is becoming more and more recognized today that the rates proposed above are the only standards upon which to appeal to the public for their co-operation, granting to the small consumer the straight meter rate and should he reach the class of large consumer granting to him, when it is proven of value, the optional or Doherty rate. The optional or Doherty rate though fought by many is now receiving the consideration that it should and is generally conceded to be an equitable, reasonable and just system of charge by reason of its obviating confusing discussions based on the quantity of the consumption and in clearly and definitely determining the items that should enter into the question of rate making.

The Hopkinson method advocated by one of the contributors in the July issue is not adapted to the large as well as small consumer by reason of the great expense placed on the customer per kilowatt of demand. This

method of charge possesses no flexibility and may serve for the time being but as in the past it was superseded by the Doherty system which though somewhat along the same lines, yet possesses a degree of completeness which is absolutely wanting in the Hopkinson system of charge. What every central station desires is new business along its existing lines, additional business where the service is already installed, even preparing to enter new fields where extensions are necessary. A system of intensive education must be pursued that the general public may be in a reasonable frame of mind and overcome the prejudices which they so often feel toward public utility corporations.

In closing I would again state that where good service is concerned and a reasonable, equitable method of charging in vogue, such a system which can be adapted to the large or small consumer, such as the Dorherty system, the question of rate making is not of prime importance. Every consumer beginning to use current on a straight meter rate may if he chooses become eligible to the optional or Doherty system of charge and whether he choose to avail himself of a lower rate per kilowatt lies entirely with him and his purchase of the current consuming device. It is not the writer's intention to attempt to cover all the space that may be allotted to him but in the short time given for reply, he has endeavored to comment on some statements made in the July issue.

Norman B. Hickox, Manager New Business Department, Muskogee Gas and Electric Company, Muskogee, Okla., on Rates in Muskogee and Oklahoma.

The situation in Oklahoma is such that the public service corporations are obliged to publish their rates and abide by them implicitly as there is a very strict discriminatory law, and any deviation from the published rates is not countenanced. It is, therefore, beyond the power of the commercial manager to make any deviation from our rates; and while this may work a hardship in some cases, the benefits gained by being able to state to our patron, either present or prospective, that he is buying his power on exactly the same basis of figuring as every other consumer, will more than compensate for what few setbacks may be occasioned on account of a lack of special rate.

Another point worthy of mention is, that it is much easier for our company to know that every power consumer is figured on the power rate and every light consumer is figured on the lighting rate, and that there is actually no deviation therefrom. The present rate is the result of some years' experience in Muskogee, and is figured to take care of all classes of business equitably, so as to return us a fair profit and warrant the connection of almost all good business. We have about 4,200 electric consumers, and every one of them is figured on the published rate.

The rates are accumulative, and for any lighting consumption under 10,000 kilowatts every consumer pays 14 cents for his first 25 kilowatts per month. It can be readily seen that as the consumption runs up the average rate decreases. For instance, 200 kilowatts cost only 50 per cent more than 100 kilowatts.

I believe that the situation here in Oklahoma more nearly approaches the ideal than where it is permitted the making of special rates or rebates to secure the most desirable business. There is no doubt, as I stated before, that this rate does work a hardship sometimes, especially on the power business of high load factor, but the large consumption occasioned by such cases will surely bring the average rate down, and as the scale has been carefully figured it covers a great majority of the cases very fairly. Before this rate was put into effect we had published three class rates, and we found that when the new rate was put in that it covered all of these classes of rates very satisfactorily, and did not occasion the dissatisfaction among our customers along the line or arguments as to who was entitled to certain class rates.

The sign rates in Muskogee are controlled flat rates, being handled by our employes, and the minimum service charge for power is $1.00 net per horse power for the first 15 horse power, 75 cents for the second 15 horse power and 50 cents for all over 30 horse power. This is not an additional charge to the rate per kilowatt, but is only the minimum to which the power bill can run on any connected horse power. It is my belief that the smaller and fewer number of rates any central station can do business with, the better off it will be, not only from an operating standpoint, but from a business-getting standpoint.

Considerations on Rates and Services Contributed by an English Central Station Engineer, R. E. Neale.

There is in England, and to an even greater extent on the Continent, a marked tendency to return to the original "contract" tariffs for domestic electricity supply. These rates were originally evolved as the simplest possible and offered the then considerable advantage that no meters were required. Though cheap and accurate meters are now available, a large capital is sunk in their provision throughout a large undertaking and, in the case of the small consumers who now form so large a percentage of the total, the revenue does not justify the annual capital and maintenance charges on the meter for which the small consumer is naturally unwilling to pay in the form of meter rent. The total annual energy loss in small watt-hour meters is also a serious expense to the central station.

The contract tariff, pure and simple, (a fixed annual charge per annum for unlimited use of every lamp installed), is obviously liable to abuse and is rarely used at the present day. The station may protect itself by the installation of time switches or, preferably, current limitors. The latter enable the use of lamps at any time and for any period and the maximum demand of the consumer is automatically limited to the value on which his annual payment is estimated. To enable the consumer to connect a greater demand, if he deliberately wishes to do so, a "peak" meter may be installed or the station may cut out the limitor for an agreed period in exchange for a suitable extra payment. The best arrangement however, is a thermal prepayment device enabling the consumer to short circuit his limitor for an hour or two by inserting a coin of correct value.

These modifications of the "contract" tariff encourage a liberal installation of fittings and have done much to popularise the use of electricity by small householders, with whom the simplicity of the arrangement and the fixed, predetermined liability are important considerations. For this reason also, ordinary prepayment meters have become very popular in poor quarters and, to the satisfaction of the consumer, must be added the security of the station against bad debts. This alone is worth something in weekly tenement areas.

Simplicity is the key note of success so far as concerns tariffs designed to beat gas competition. The average householder argues that he can get gas at any time and at any rate for a fixed payment per 1,000 cubic feet. Load factor arguments and such, he regards as cloaks to iniquity and, until stations adopt a straight forward charge per Kw. hour or, better, a contract rate, much domestic supply business will be lost. Temporary inconvenience and loss to the station would be more than recouped by the rapid development obtained and, in many towns, the power load already forms so high a percentage of the total that the lighting peak is a bogey of the past. In such cases, there is nothing against obtaining the maximum possible sales at any time and rate the household desires.

The abolition of meter rents and the provision of "free" wiring and lamp supply are concessions which have done much for domestic supply in many towns. Often the cost of the concession is fully covered by the increased profits following the greater current sale. In other cases, the rate per kilowatt hour is slightly increased to cover all "extras" and the consumer is better pleased than though the same bill had been made up of a number of items. Tariffs are built on a foundation of psychology.

Personal attention is almost imperative to the getting of new business in this country. Publicity by mail and in the Press is useful as an auxiliary but recommendation by friends and personal attention from the station staff are far more powerful agents in obtaining additional consumers. Where several tariffs are available, it is worth while going into the matter with the client. What is cheaper to him, is, if the tariffs are properly designed, also cheaper to the station so that the latter will lose nothing by considering the consumers pocket but will, on the other hand, gain his good will and trust and, sooner or later, additional business through his recommendation. Carefully compiled station records are invaluable to the staff for estimating purposes and in providing actual experience for the canvasser to quote. "Mr. S. saves $10.00 a quarter on a smaller lay-out than yours," is a more convincing argument, to the average man, than "Look through these estimates and you'll see that you must save 10 per cent, assuming you do so and so."

Sympathetic personal attention is to be distinguished from pandering to the, (usually imagined), "hardships" of the small consumer. In my own experience, several such men have grumbled because their bill was about half a dollar higher than in the corresponding quarter of last year, (or the year before), and this on a total payment of $5.00 or so per annum. I can quite understand that one of your large companies has found it necessary to circularise its consumers as to "Why Your Bill is Heavier in Winter than in Summer."

Many stations prefer to encourage such demands as will improve the load factor of the undertaking rather than to seek any class of fresh load. This attitude is quite justifiable, particularly in a small concern with small capital resources. There is a grave risk of scaring prospective clients if complicated tariffs are devised but much can be done by special discounts and by judicious application of maximum demand meters and limited hour or two rate meters. A handsome discount, if arranged on a reasonably simple basis, is always a tempting bait.

In developing power loads, special caution is necessary. Many stations have long since passed the stage in which any power load was welcome as increasing the day load; in a number of industrial towns, the morning and afternoon power peaks are much higher than the lighting peak. Under such conditions, the station, while making every endeavor to secure factory and workshop supply, can afford to make terms on a load factor and power factor basis. Load factor tariffs are now quite common, though there are some cases which could not well be supplied on this basis. For instance, the electric steel furnace at Sheffield throw a rapidly fluctuating load of 800 to 1,000 Kw. on to the mains at intervals and there are rolling mills which are liable to require 500 to 800 Kw. without notice, at any time of day or night. A load factor tariff would be prohibitive but the loads are too valuable to lose hence the only solution is tremendous stand-by capacity at the station, with turbo-alternators of 100 per cent overload capacity for one-half hour.

Power factor has not yet been much taken into account in arranging supply rates but a load of low power factor may prove very unremunerative, particularly if supplied through comparatively low tension feeders. The increasing magnitude of alternating current power loads is calling attention to the advisability of taking power factor, as well as load factor, into account when framing tariffs. Simplicity is of minor importance in power rates. The consumer, or his engineer, is in a position to understand technical arguments and insists on supply at the most favorable rates possible which can only be arranged by taking into account the various factors influencing the station costs of production. (The average domestic consumer will never follow such arguments though they are for his own good. Complexity, in his view, means swindling and the only safe procedure seems to be to arrange one, or a few, dead flat rates). A number of small works are adopting "restricted-hour" power supply and can thus, (with benefit to the station load factor), be offered rates which on account of the consumer's low load factor—would be quite unprofitable if extended to unlimited supply.

Work of Philadelphia Electric Company Section of N. A. L. A.

At the recent annual meeting of the Philadelphia Electric Co., section of the N. E. L. A. the work of the past year was reviewed. It was shown that the organization is well founded, made up as it is of branches. There is now a meter department branch, a commercial department branch and an accounting department branch, each holding monthly meetings in addition to the main section monthly meetings. Specific educational work is being carried out in the various branches, and general educational work carried on by the main section. The plan last year, which was very successfully carried out, was to secure as speakers on general subjects, men of the very highest reputation in industry. This plan was a success in every way and no doubt will be carried out the coming year.

The officers for the coming year are as follows: B. Frank Day, chairman; Frank A. Birch, vice chairman; Jos. B. Seaman, secretary; H. R. Kern, treasurer.

Living rooms and libraries should have a 4 light ceiling, and two, four, or six side wall outlets, also a floor plug. Dining rooms should have a center ceiling outlet and outlets beside the dresser. Drawing rooms or salons should have a brilliant light uniform throughout their entire area.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

OPEN VS. CLOSED STATOR SLOT CONSTRUCTION.

Editor Southern Electrician:

(311) There is a certain motor manufacturer that makes up the stator core of its induction motors of punchings of sheet steel with open coil slots. These slots are closed when the winding is in place by metallic slot bridges. It is claimed that these bridges secure the same results as the overhanging edges of the semi-enclosed slot. The motors thus made up are said to have high efficiency, high power factor and low starting currents as against low efficiency, low power factor and high starting current of those motors made up with open slot construction in stator. If these claims are true, what are the particular electrical or magnetic conditions that are changed by the metallic bridges to bring about such decided benefits in motor operation? F. A. D.

INSULATION OF WIRES PASSING THROUGH TREES.

Editor Southern Electrician:

(312) I would like advice from central station readers as to the clearance from limbs of trees allowed where primary lines must be carried through trees. Is it necessary to tape wire or furnish other insulation? Can the electric light company be held responsible for damage done to shade trees? H. T. G.

CALCULATING ILLUMINATION.

Editor Southern Electrician:

(313) Will some reader kindly explain through the question and answer department the difference in results obtained in figuring illumination by the point to point method and the total flux of light method. Why should there be any difference and which is correct? Can a table or formula be given for the lumens represented by a lamp of certain voltage and a certain holophone reflector. If so please give such. B. E. F.

WHY COST OF 2,200 VOLT MOTOR MORE THAN 550?

Editor Southern Electrician:

(314) It is often found that an induction motor wound for 2,200 volts is higher in price than one wound for a lower voltage say 550 volts, having same frequency, rating and speed. I would like to know the factors that make up the increase in price. C. E. W.

SIZE OF POLES FOR DISTRIBUTION SYSTEM.

Editor Southern Electrician:

(315) I would like to know of a simple rule or formula for determining the size of pole to use where more than one service drop is to be taken from it and when these vary in length. E. C. T.

WATT-HOUR OUTPUT OF STORAGE BATTERY.

Editor Southern Electrician:

(316) I am informed that the same watt hour output cannot be obtained from a storage battery in two discharges if discharged each time at different rates. If this is true what are the reasons? W. S. P.

Voltage at Center of Distribution. Ans. Ques. No. 265.

Editor Southern Electrician:

In the solution of transmission line problems it is usual to assume a certain voltage, current and phase relation at the receiving end and resolve the current into components in phase and in quadrature with the receiving emf, the generator emf being given by the equation,

$$Eg = \sqrt{[(E + IpR + IwX)^2 + (IwR - IpX)^2]} \ldots\ldots (1)$$

and the phase relation is determined by the equation,

$$\cos \Theta = (E + IpR + IwX)/Eg \ldots\ldots\ldots\ldots (2)$$

where Eg is generator emf, E is emf at receiving end, Ip is power component $= I \cos \Phi$, Iw is wattless component $= I \sin \Phi$, R is line resistance, X is line reactance, $\cos \Phi$ is power factor at receiving end and Θ is angle between Eg and E.

In the present problem this method must be modified since E is the unknown quantity instead of Eg. We will therefore resolve I into component in phase and in quadrature with Eg instead of E, which can be done by assuming a certain angle between I and Eg for one phase and determining the angles of the other two phases from the

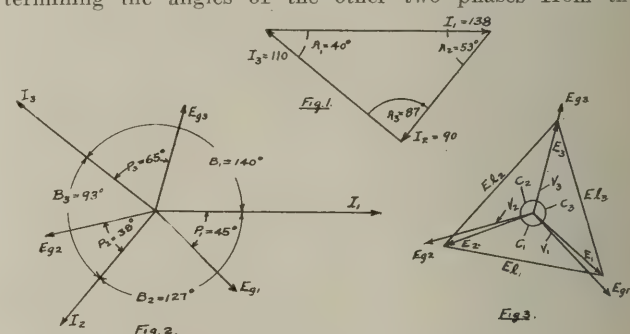


DIAGRAM OF VECTOR RELATIONS.

known phase relation of the three currents. If there be no neutral wire the vector sum of the three currents must be zero and they will necessarily form a triangle from which their relative phase relations may be determined either by measurement from the diagram (Fig. 1) drawn to scale, or by the following equations:

$$\cos A_1 = M/I_3;\ \cos A_2 = N/I_2$$

$$M = [I_1 + (I_3^2 - I_2^2)/I_1]/2;\ N = [I_1 - (I_3^2 - I_2^2)/I_1]/2$$

the third angle A_3 is of course $180° - (A_1 + A_2)$.

By this method the angles are, to the nearest degree,

$$A_1 = 40° \qquad A_2 = 53° \qquad A_3 = 87°.$$

Transferring the vectors I_2 and I_3 to form the three-phase Y, we get the diagram shown in Fig. 2 and the angles are,

$B_1 = A_2 + A_3 = 140°$, $B_2 = A_1 + A_3 = 127°$, $B_3 = A_1 + A_2 = 93°$.

We will assume that Eg_1 is 45° ahead of I_1 as drawn in Fig. 2, and since the generator voltages are equal and 120° apart, we can easily see that if P_1 is 45°, P_2 will be 38° and P_3 65°.

The component of current I_1 in phase with Eg_1 is $I_1 \cos 45° = 138 \times .707 = 97.56$ and the quadrature component, $I_1 \sin 45°$ is also 97.56.

$$E_1 = \sqrt{[(Eg_1 - IpR - IwX)^2 + (IwR - IpX)^2]} = \sqrt{[(1274)^2 + (-68.3)^2]} = 1276 \quad (3)$$

$\cos V_1 = 1274/1276 = .9984$ where V_1 is the angle between Eg_1 and E_1, therefore $V_1 = 3° 15'$.

In phase 2, the angle between I_2 and Eg_2 is 38°, $I_2 = 90$ and the phase and quadrature components are 70.92 and 55.4 respectively. From these values $E_2 = \sqrt{[(1338)^2 + (-57.4)^2]} = 1339$ and $\cos V_2 = 1338/1339 = .9992$ $V_2 = 2° 15'$. In phase 3, the angle P_3 is 65°, I_3 is 110 and $E_3 = \sqrt{[(1320)^2 + (-5.93)^2]} = 1320$, and $\cos V_3 = 1$. In this phase the quadrature component $(IwR - IpX)$ is so small due to the two terms being nearly equal that we can see without calculation that E_3 is practically the same as its phase component, 1320, and is in phase with Eg_3.

We now have the values of the phase voltages at receiving end as well as their phase relation with their respective generator phase voltages, and can easily calculate the angles between the phase voltages at receiving end since the generator phase voltages are known to be 120° apart. Let the angle between E_1 and E_2 be C_1, and let $D_1 = 180° - C_1$, then the line voltage between E_1 and E_2, El_1 is,

$$El_1 = \sqrt{[E_1^2 \sin^2 D_1 + (E_2 + E_1 \cos D_1)^2]} \quad (4)$$

If the phase voltages were 120° apart, D would become 60° and the equation would be

$$El_1 = \sqrt{[E_1^2 + E_2^2 + E_1 E_2]} \quad (5)$$

and of $E_1 = E_2$ it becomes the well known expression for three-phase line voltage, $El = E\sqrt{3}$. The value of Eg in the above is $2500/\sqrt{3} = 1440$, 2500 being the given line voltage at generator. The value of R in the above calculations is .5 and X is 1.2. R will vary with the temperature and the real value of X is slightly less than 1.2.

In each phase it is seen that the quadrature component is of the same sign and therefore the angles V_1, V_2, and V_3 will be of the same sign, that is, the phase voltages E_1, E_2, and E_3 will each be on the same side of its corresponding generator phase voltage. See Fig. 3.

The angle between E_1 and E_2 is $C_1 = 120° + V_1 - V_2 = 121°$

The angle between E_2 and E_3 is $C_2 = 120° + V_2 - V_3 = 122° 15'$.

The angle between E_3 and E_1 is $C_3 = 120° + V_3 - V_1 = 116° 45'$.

$D_1 = 59°$ $D_2 = 57° 45'$ $D_3 = 63° 15'$

The voltage between line 1 and 2, referred to in question, calculated by equation (4) is 2278. The other line voltages are 2326 and 2210. If we assume that the phase voltages are 120° apart and calculate the line voltages by equation (5) they will be 2264, 2302 and 2248. Comparing these values with the true ones shows that for accurate work it is necessary to find the exact phase angle.

The calculation for other values of the arbitrary angle between Eg and I is made in the same manner as the above, but if in any case one of the quadrature components (IwR — IpX) should be of different sign from the other two, then E for that phase must be drawn on the opposite side of Eg to which it is drawn in the other two phases, and the angles between the phase voltages determined accordingly.

In the above it is assumed that I_1 is 138, I_2 is 90 and I_3 is 110, but it is evident that it might be that I_3 is 90 and I_2 110, in which case P_2 would be 25° and P_3 52° if P_1 were 45°. These new values would materially alter the results of our calculation and therefore it is necessary to know whether the 90 ampere phase or the 110 ampere one follows the 138 ampere one. We might exchange the phases by reversing the connections as Professor Wood suggested in his graphical analysis of this problem, if the calculations would indicate better results by so doing, but in that case all the polyphase motors would run backward and would have to be reversed.

T. G. SEIDELL.

Factors in White Way Systems. Ans. Ques. No. 285.

Editor Southern Electrician:

Nearly all the decorative systems installed have used multiple connections. This arrangement is simpler and requires no special devices to compensate for lamp voltages. The watts used varies a good deal with the wishes of the community, and is essentially a commercial consideration. We find 3-light posts having all the way from two 40 watt and one 60 watt lamp per post, up to three 100 watt lamps, and we find five lamp posts running from four 40 watt and one 60 watt up to five 100-watt lamps. The average seems to be about 175 watts for the 3-light and 375 watts for the 5-light. The spacing is largely also a matter of local preference. We find spacings from 30 to 100 feet the average being about 75 feet. The watts per post and the post spacing bear a relation to each other usually expressed in watts per foot front. This figure is pretty well defined, being in the majority of cases between 5 and 7, although it goes as low as 2 and as high as 12. Evidently the more wealthy a business section the easier it will be to get the property holders to pay for a high wattage per foot front. Since it is the sidewalk and not the street which is illuminated the spacing does not as a rule bear any relation to the width of street. Pendant lights are considered somewhat the best as it does not take such careful construction to protect from the weather, but a great many installations use the upright globes because the committee in charge considers that they were more artistic. The General Electric Co., the Adams Bagnall Co., and the Macbeth Evans Co., each have published booklets giving very valuable and interesting information on ornamental lighting.

Trouble With Generator. Ans. Ques. No. 286.

The machine marked "B" in the sketch on page 173 of the April issue, must be operating differentially since when used alone the voltage drops as the load increases. That is, the series field must be opposing the shunt field. When the two machines are operated together, the equalizing connection overcomes this condition. The remedy would be to reverse the series field connections. In regard to the second part of Mr. Hill's question, it depends upon the load conditions. No change in the armature will be necessary if the present load does no overheat the machine. Reducing the voltage has reduced the capacity in direct ratio, and if full advantage is to be taken of the size of the machine, the armature would have to be rewound with larger wire and fewer turns.

Voltage for Induction Motors. Ans. Ques. No. 290.

By studying the distribution voltages and systems in common use, we see that the greater part of the induction motor load can be supplied with 220 and 440 volt, 2 or 3 phase current, and 110 volt and 220 volt single phase. We

have, as shown in the figure, in nearly all systems, a 2200 volt distribution system. On this we find two general kinds of transformers, called "lightning" and "power" transformers. The former has secondaries arranged for 110 or 220 volts. It is usual to connect the secondary coils in series with a tap at the point of connection and run a 110 220 volt 3-wire system to the houses for lighting. Small motors may be taken from this circuit, mostly 110 volt or 220 volt single phase of 5 H. P. and less. The power transformer also has a divided secondary, the coils ot which may be connected to give either 220 or 440 volts. It is quite necessary that there should be a complete range of sizes of motors for each of these voltages, for if a certain voltage is adopted as standard for a certain factory, all the motors large and small should be selected accordingly, as

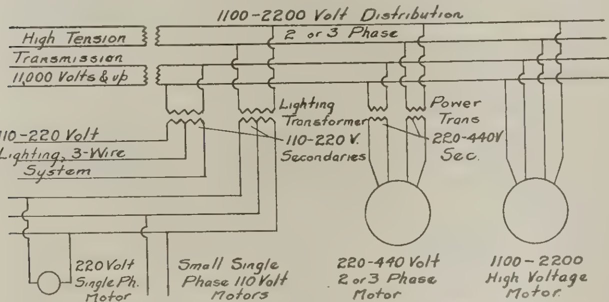


DIAGRAM OF DISTRIBUTION ARRANGEMENTS.

any other plan would complicate the wiring and transformer arrangement. A voltage of 110 is hardly ever used on polyphase work, and 550 volts is not common. For quite large motors, 1,100 and 2,200 volts is very satisfactory, but it would not be possible to make this voltage a standard for everything above a certain size, for the reasons given, i. e. lack of flexibility. Standardization cannot be carried to the point of inconvenience.

Frequency of Systems. Ans. Ques. No. 295.

The first A. C. systems were used for lighting only and were single phase, 133 cycles. As the art developed and as machines were made larger in size, the tendency became apparant, to lower the frequency, partly because it simplified the generator design and partly because it improved the operating characteristics of the induction motors. After some experiment 60 cycles was selected as about the lowest frequency that would not cause flickering of the lamp filaments, and it is today the standard frequency for lighting circuits. For power purposes, however, especially for single single phase commutator type motors, a still lower frequency was desired and after a little time 25 cycles was selected as standard for power circuits, where there is practically no lighting. Some lamps give good results on 25 cycles and others do not, so that in general, 25 cycles is used only for power. The size of the system or the length of the line is not so much the deterimning factor in this selection, as the character of the load.

A. G. RAKESTRAW.

Candle Power in Horizontal and Tip Directions. Ans. Ques. No. 298.

Editor Southern Electrician:

Undoubtedly the arrangement of the filament exercises the chief control over the candle power distribution of a glow lamp. The cylindrical or "drum" method of winding filaments, at present almost exclusively employed for metallic lamps of medium or high candle power, gives maximum horizontal and minimum tip candle power and no other arrangement of the filament will yield a greater percentage of the total light in a horizontal direction. The form of the glass bulb has, of itself, little influence on the light distribution. Thus, referring to (A) of Fig. 1, it will be seen that the effect of the glass is merely to displace a given ray parallel to itself through a distance determined by the thickness of the glass and the inclination of the latter to the incident ray, (assuming the glass to be parallel, which it is within practical limits). Taking the whole of the rays from the lamp into account and allowing for the fact that the bulk of the light leaves at a very obtuse angle to the glass of the globe, the effect of the latter on the light distribution will be very slight. As regards the tip or "pip" of the lamp, this does offer considerable obstruction to the downward illumination and is liable to produce a "streaky" effect on a book held below the lamp. For special purposes, lamps with side pips can be obtained at an increased price, (usually 2.5 to 5 per cent increase). As shown by (B) of Fig. 1, the glass near the pip will simply traverse a considerable proportion of the rays but some of the latter will have a very long path in the glass and will thus experience considerable absorption, (particularly as the transparency of the glass is appreciably reduced by the treatment undergone during sealing). Again, the walls of the pip itself are not parallel so that a prismatic effect is obtained.

There have lately been designed a number of "focus" lamps in which the filament is arranged between two rings of hooks, (forming circles of different diameters, the larger being at the cap end of the bulb), thus giving a conical disposition of the wires. In a recent French design along these lines, a comparison between 20 watt lamps in which the filaments respectively enveloped the frustum of a cone and a cylinder gave the following results: Horizontal c. p. = 16 and 16; mean spher. c. p. = 13.4 and 12.2; mean lower h.—s. c. p. = 15.4 and 12.6; total lumens = 168 and 153; lumens in lower hemisphere 97 and 79. A specially complex "focussing" design for metal lamps in which the filaments are arranged in successive conical banks and staggered, is covered by American Patent 1001382, (1911). In other cases, the filament is arranged as a flat gird perpendicular to the cap axis. In all such cases, a side pip should be used or the pip absorption will be serious, which it is not in the standard drum wound lamp giving maximum illumination in a horizontal direction and depending on

Table I. Covering shapes and proportions of Lamps used in England.

Shape	Lamp	Taking Bulb Length as Unity Length of Filament	(see sketches)	Dimension,
a	200-250 v. ; 16-32 cp. Carbon	2.9	(1)	0.35 - 0.45
	230 ; 30 cp. Tungsten	13.8	(2)	0.75 - 0.80
b	110 ; 16 cp. Carbon	2.45	(3) (4)	0.35 0.65
c	200 ; 32 cp. Carbon	3.2	(5) (6)	0.27 0.84
d	100-120 16 cp. Tantalum	8.0	(7) (8)	0.63 0.75
e	240 ; 50 cp. Tungsten	4.5	(9) (10)	0.39 0.56
f	250 ; 350 cp. Tungsten	9.6	(11)	0.88
g	50-80 ; 10-12 cp. Tungsten	2.15	(12) (13)	0.38 0.69

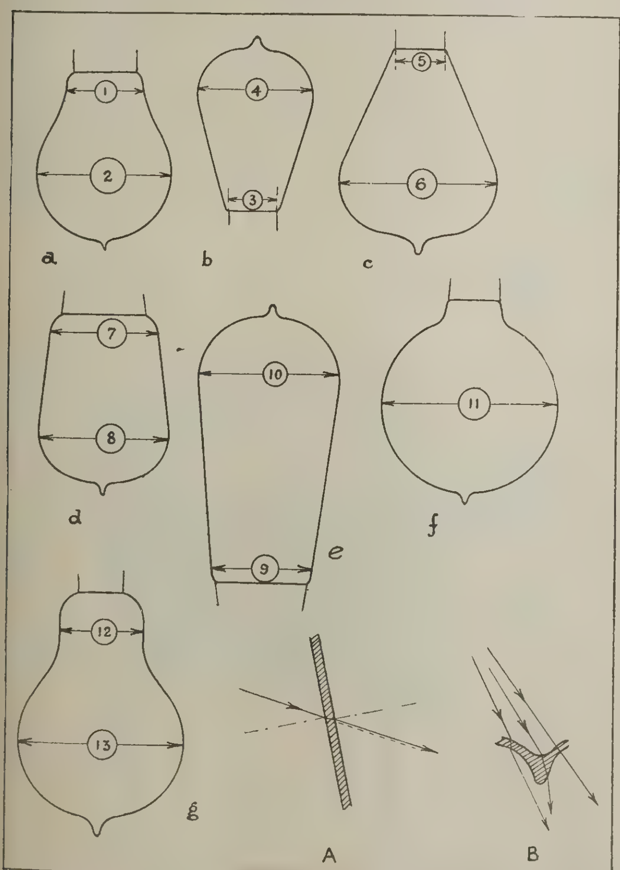
external globes or reflectors for the attainment of a "focussed" or other special light distribution. The mean spherical divided by mean horizontal candle power of a standard tungsten lamp is about 0.78 — 0.79.

The accompanying sheet of sketches Fig. 1, and Table I covers the shapes and proportions of a number of lamps used in this country. Shape *a* has been largely used in carbon lamps and has lately been used for tungsten filaments; *b* is a very common carbon shape: *c* is a shape sometimes used for carbon lamps from which increased downward lighting is required; it is often convenient in shop window lighting etc.; *d* represents the original tantalum lamp bulb now displaced by shape *e* which is also used for tungsten lamps of moderate candle power; the spherical bulb *f* is used for carbon, tantalum and tungsten lamps of high candle power and *g* shape has been used for carbon lamps in the past and is now being used to enclose low candle power tungsten filaments.

The bulb proportions given in the table may be accepted as reliable averages but it is possible to vary the length of filament in a given bulb within very wide limits and the lengths given are average values for lamps of the stated candle power and voltage. The unit of measurement throughout is the length of bulb from the base of the cap, at junction with glass, to the root of the pip.

Bastian Meters. Answer Question No. 303.

The Bastian meter is one of the simplest and most accurate D. C. types extant and is very popular in this country, (England). It is used in about 105, (25per cent), of our central station areas with perfectly satisfactory results. Other types are, of course, also used in these areas but, though there is no precise data available as to the



Shapes and Proportions of Lamps.

number of each type in use, the percentage of Bastians is undoubtedly high. The accuracy of electrolytic meters, of which this make is typical, is theoretically absolute and there is no difficulty in guaranteeing an error not greater than plus or minus 2 per cent at all loads, so that as regards actual error at all loads and percentage error at low loads, the electrilytic meter companies very favorably with the best motor types. An error not greater than 3 per cent between 1/5 and 6/5 load is generally considered very satisfactory in ampere-hour meters, the energy accuracy of which obviously depends essentially on the voltage constancy of supply. The maintenance required by the Bastian meter is negligible and refilling with distilled water is a moment's task. The solution used in the latest types freezes with great difficulty and overloads produce no mechanical damage or permanent error. There is no pressure circuit and hence no loss such as continuously occurs in the voltage circuit of motor watt-hour meters. The voltage drop in the meter is about 1 volt in the shunted type, (which should always be used); the drop in the unshunted type is 4 or 5 volts. Quite good temperature compensation is easily attained, in the shunted type.

Oil on Motor Windings. Ans. Ques. No. 304.

If the motor windings are not protected by any special oil-proof impregnation or varnish, trouble will soon arise under the conditions specified but, if the conditions of working were taken into account in insulating the machine, the accumulation of meal should have no serious effect. It would be better to use a totally enclosed machine in such a service, allowing for the extra heating which will occur when enclosed. In the case of a d. c. machine, I should certainly recommend total enclosure, for the sake of the commutator and brush gear, but this argument applies to a less extent to slip ring induction motors and not at all to squirrel cage machines.

There are a number of English and German, (and no doubt American), firms able to supply insulating enamels and varnishes which will resist water, oil, acid and alkali and from the lengthy list of their products there should be no difficulty in selecting a number which will perfectly resist cotton seed oil, while answering any other special needs of the case. I should not anticipate any damaging action by cotton seed oil on most of the varnishes used by good motor makers; indeed, it would probably have a beneficial effect on a number of varnishes which, being mixed with a drying oil, (linseed), are liable to continue "drying" till they become hard and brittle. However, this action should not be relied upon—a good oil-proof, flexible varnish should be employed in the first place. Suitable grades, by a well known English firm, cost $1.25 — $2.00 per gallon and no doubt American firms will supply at about the same rates.

Apart from the question of damage to insulation, it is probable that the heating of the motor will be considerably aggravated by the collection of meal on the windings. I should recommend the daily or weekly use of a portable blower or vacuum cleaner.

The danger of allowing oily meal or oil and dust to collect in windings was recently instanced in a 120 horse power three-phase wound-rotor induction motor. The rotor shifted slightly on its "spider" thus chafing the insulation of the bottom conductors in the slots. The accumulation of oil and dust established a tolerably good short circuit be-

tween the bared wires and thus practically converted the machine into a squirrel cage motor with the result that it would operate full load at full speed when the blades of the liquid starter were right out of the solution.

CECIL TOONE, ENGLAND.

Cost of Residence Wiring. Ans. Ques. No. 300.

Editor Southern Electrician:

From the information given by H. T. R. question 300, it is out of the question to give cost of wiring per outlet when no data as to sizes of room is given nor plan of rooms shown. In fact a cost per outlet is a very unsatisfactory method to use in estimating work of this kind for no general rule will anything like cover every case. It is always wise to either measure the wire runs or lay them off to scale on a plan of the house and eliminate guess work as far as possible.

It has been found however for ordinary work with conduit that the following general division of costs holds good. Labor 40 per cent; conduit 22 per cent; wire 18 per cent; Switches, outlets, and extras 20 per cent. Having therefore determined upon the amount of wire very carefully the estimate can be made up from this data.

H. F. BOYLE.

House Wiring. Ans. Ques. No. 300.

Editor Southern Electrician:

In regard to wiring a house, the net cost of no two jobs will be exactly the same due to varying conditions so that each case must be figured separately if a profit is desired on the work. Some firms have a fixed charge per outlet whether near or far apart, however, in most cases it is not a fair or safe proposition for a contractor. Our central station company charges $1.50 per outlet for labor and material included for drop lights and plain knob and tube work. A charge of cost plus 10 per cent is made additional for all fixtures and conduit. We figure that at this rate out wiring department just about breaks even and the prices are maintained to help get new customers on the lines.

E. D. DUMAS.

Factors Limiting Transmission Voltage. Ans. Ques. No. 302.

Editor Southern Electrician:

In regard to the first part of this question as to the factors limiting voltage on transmission lines, it must be remembered that to transmit a certain amount of electrical energy from the generating station to the receiving station at different voltages and the same loss in the line, the weight or cross section of conductors varies inversely as the square of the voltage used. In long distance transmission lines the largest item of investment is copper so that very high voltages are desirable. However as the voltage is raised the cost of transformers, switching apparatus, lightning equipment and insulators increase also so that the economic operating voltage must be determined for each case, expressing each element of cost as a function of the voltage and equating the differential with respect to voltage to zero. Further than these items limiting voltage there is a limitation to the electric strength of air, above which a loss occurs by corona.

In reply to the latter part of the question, the writer quotes, Mr. R. A. Philips, page 258, Vol. 30, A. I. E. E., as follows. "There are no limitations to the amount of phase difference, therefore none to unlimited extension at constant potential but in distant parts of a large system the difference may be so great that one machine may be one or more complete cycle or even revolutions behind another." This holds true of a large system and between any two stations, however the phase difference between inter-connected systems is limited between consecutive stations. A careful analysis of this problem is given in the reference made above.

H. S. ATWELL.

Bastian Meters. Ans. Ques. No. 303.

Editor Southern Electrician:

We have about seventy-five Bastian meters on our lines and find that they are far from satisfactory and accurate. The entire current on the circuit on which the meter is placed, must pass through the solution in the glass tube. I have had several meters act like rheostats that is the current for one or two lamps would pass through without much drop in voltage but when more lamps were turned on the voltage would drop considerable.

When the capacity of the meter was reached the voltage would be so low that the lamps on the circuit would not light. I tried to remedy the trouble by cleaning the tubes and electrodes and using rain or distilled water for filling the tubes but nothing seemed to do any good. The only way I could get them to work was to put in a new set of electrodes and they cost $3.50.

The reading is taken from a scale on the side of the tube which works very well when the meter is in good condition. A layer of colored oil floats upon the electrolyte to show a definite line by which t oread. The electrolyte however often becomes discolored from the electrodes and becomes inky when it is impossible to take any readings.

I have had three years experience with Bastian meters and find that they are not accurate, they will register many times as much as they should, and there is no way to calibrate them.

C. A. VANN.

Grounding Secondaries. Ans. Ques. No. 307.

Editor Southern Electrician:

In answer to question 307 by G. S. R. in the July issue, I offer the following: The grounding of secondaries of transformers is a protection to life as well as to the transformer. The grounding prevents a high voltage occurring upon the low-tension winding in case of a breakdown or other electrical connections occurring between the high and low-tension windings, but if the neutral of only one winding is grounded, the strain from this winding to ground will be limited to half of the normal voltage. The strain from the ungrounded winding to ground, to iron and the grounded winding will not be thus limited, obviously if neutrals of both windings are grounded this difficulty is overcome, but conditions are such at times when only one winding can be grounded.

In the case of a breakdown without the secondary being grounded any person touching any part of the low-tension system, such as a lamp socket for instance, will receive the full high-tension voltage. The Underwriter's recommend the grounding of secondaries as a protection to apparatus as well as to life.

Open Delta vs. Other Connections. Ans. Ques. No. 309.

In answer to question 309 by W. T. B. in the July issue I would say that the only advantage from using open delta transformer connections is that two transformers will cost less than three. As to economy of space and less weight transformers that are to be operated open delta will weigh about the same as three transformers to transmit the same power.

Some of the disadvantages arising from use of open delta connection are: for the same heating, that is the same current value, two transformers V connected will carry only 58 per cent as much load as three transformers connected delta. Again for a non-inductive load, as a lighting load, V connection requires 15½ per cent more transformer capacity than the power transmitted. For an inductive load the power factors for one transformer will become more and for the other less than cos. 30°, which will make the regulation better on one and worse on the other transformer. If two transformers must be used for phase transformation or as plain step-up or step-down transformers, T. connection will give the best results of any connection. The economy of V connection is very small if there is any at all.

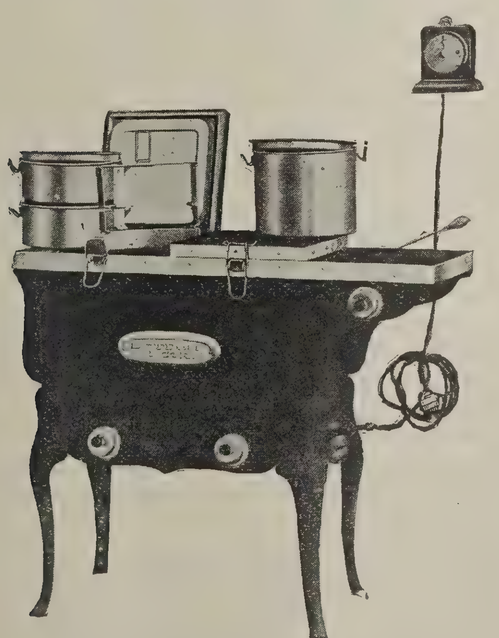
W. D. Kellogg.

New Apparatus and Appliances.

Detroit Fireless Electric Stove.

Several designs of electric stoves are now on the market, each having particular features and particular claims for such. The illustration shown herewith is a design of stove manufactured by the Detroit Fireless Stove Co., of Detroit, Mich. These stoves are built like a range made of planished steel with no inflamable material of any kind used. The lids or oven doors are made of planished steel with aluminum lining and made to form a water seal. There is an extra bead or ridge which runs completely around all four sides of the lid which fits into a corresponding groove in the top of the oven. The steam condenses and collects in this groove forming the water seal, said to be steam tight, heat, water and odor tight. Each of the compartments or ovens is insulated by corrugated asbestos boards and the whole design is such as to use the heat for cooking the food most economical.

The style of stove shown is a convenient size for families of two to seven persons and is furnished with three solid aluminum kettles with covers. One electric heated griddle plate for toasting, frying, etc., and eight feet of insulated connecting cord and clock regulator for shutting out the current at the desired time. The regulator is seen in the illustration above the stove at the right. This is a very useful device making the stove automatic as far as possible. The stove can be operated from a lighting socket on one heater at a time and proper fuse can be inserted to use both ovens if desired.



The Detroit Fireless Stove.

The heating element is located below a solid cast iron bottom of the cooking compartment and can be removed from below if for any reason this is desired but in operation it is secure from water or steam and is perfectly rigid. The heating element is said to consume from 200 to 250 watts.

Further Improvements in Holophane.

A new standard line of high efficiency reflectors has been announced by the Nelite Works of General Electric Company. This line will be known under the trade name of "Xtraficiency" and is claimed not only to be of considerably greater efficiency than present standard line of Holophane reflectors, but the most efficient lighting glassware yet made and Photometric Electrical Testing Laboratories, are offered to substantiate this statement.

In announcing the new line, Mr. W. F. Minor, in charge of the efficiency glassware sales of the Nelite Works, said: "Now that we are in position to sell every type of illuminating glassware, we realize the distinct position of each type. At one time, the industry undoubtedly lost its head over Holophane—that is to say, the efficiency and case of installation of our product was such that Holophane glass was frequently used in places where another type of glassware might have served to better advantage. The natural result of this over-enthusiasm for high efficiency glass led in time to an equally eroneous prejudice in favor of opal glass, so that today we see many installations equipped with our own opal or others which might have been equipped with Holophane.

"The new "Xtraficiency" line of Holophane glassware will help to define the proper place for each class of equipment. Where efficiency is the chief consideration, Holophane is without doubt the proper equipment. As decorative necessity or architectural restrictions call for more decorative glassware, the opals find a natural place. I think that in the future we will not see prejudice in favor of any particular type of lighting equipment carried to the lengths it has been carried in the past, and that the glassware

selected for each installation will be selected with view to the exact requirements of the case and not in accordance with the ready-made arguments of the man making the installation."

The new "Xtraficiency" line will be offered about the first of August and in ample time for the industry to use it on Fall installation work.

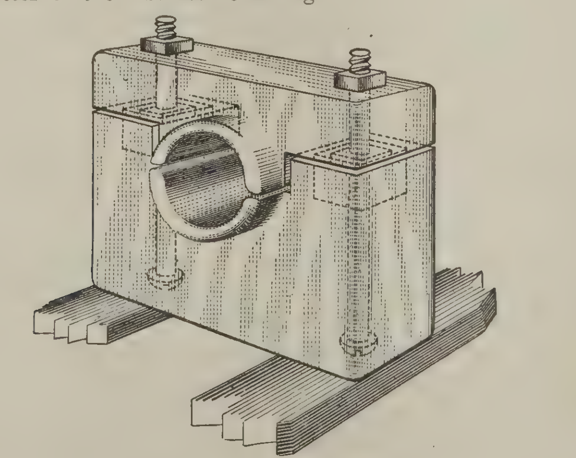
Porcelain Cable Clamp.

The porcelain clamp insulator, shown in the accompanying illustration, has been designed particularly for high voltage switchboard construction, but lends itself with equal advantage to low-voltage work, where a high grade of excellence is the first consideration. The design has been worked out with careful attention to the length of leakage paths to ground, clamping arrangements and ease of installation by the manufacturers, The Fairmont Electric and Manufacturing Company, of Philadelphia.

The clamping members comprising the insulator, grip the cable uniformly between two circular tube-like surfaces approximately two inches in length, as indicated by the projections on each side of the clamp. All edges are carefully rounded to avoid any possibility of injuring the cable covering due to forcing sharp corners or grooved inner surfaces into the insulation. This type of construction has a further advantage in practically doubling the surface leakage path to ground. It is further evident that on account of the larger clamping surface presented, the wire will be held firmly with much less pressure per unit area of contact surface.

The leakage path from conductor to bolts, between the insulations has also been carefully worked out so that, at this point, the path to ground is approximately the same length as the path over the surface of the porcelain to the insulator support. Another important feature included in the design is the method used in bolting the insulator to the switchboard framework. In this type of construction the lower half of the insulator may be bolted to its support and properly aligned before the wire or insulated bus is fastened in position.

This is particularly advantageous in switchboard work where the bus bars and circuit tops consist of heavily insulated solid conductors which must be straight before being placed on the insulators. In addition the clamping of the cable is rendered entirely independent of the insulator fastenings and the pressure on the wire can be adjusted to suit the strain placed upon the cable and the character of the insulated covering.

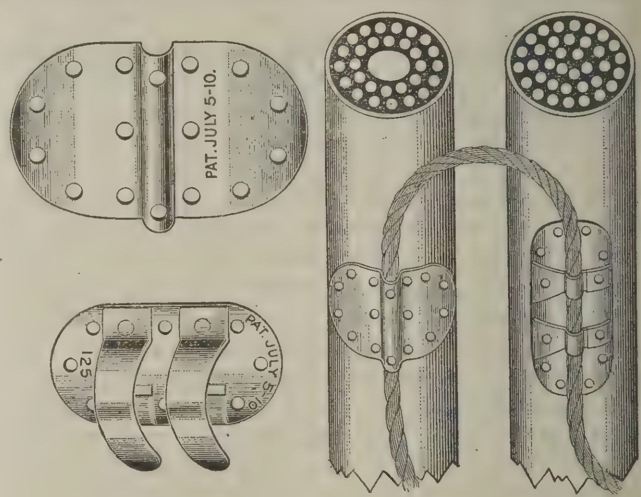


PORCELAIN CABLE CLAMPS.

Attaching Plates for Ground Wires.

To provide a convenient means for attaching bonds or grounding wires to cable sheaths or piping, the patented attaching plates and bond wire shown in the accompanying illustration have been placed upon the market by T. J. Cope, of Philadelphia. These are made in the two styles shown the one with the rigid bond wire connection being manufactured in two standard sizes. They are furnished with bond wire of any desired size and length.

The plates are made of copper, perforated as shown, and are completely covered with a film of solder for protection against corrosion, as well as for convenience in application. In applying the plates, the surface of the



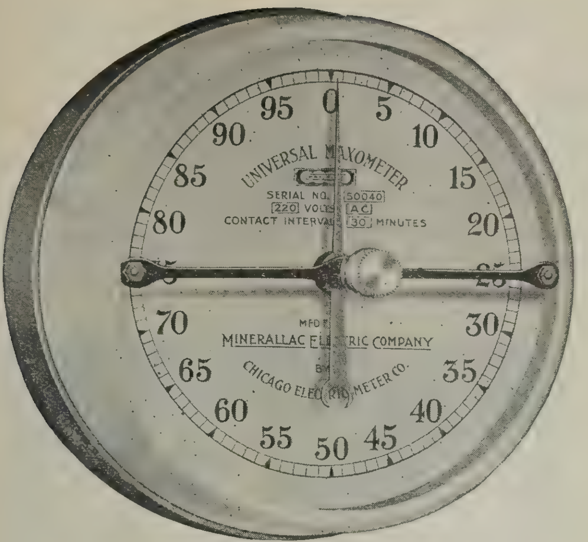
COPE BOND WIRE AND ATTACHING PLATES.

cable sheath which is to be protected is scraped clean at the point of attachment, the plate bent to fit the contour of the cable sheath, and the turned plate sweated on by using moderately hot soldering iron. The plates are made sufficiently thin to be easily bent as required by the pressure of the fingers and the perforations enable an even and continuous solder joint to be made over the whole surface of the plate in contact with the cable sheath. The standard form of bonding wire furnished with the plates is a ¼-inch stranded copper cable composed of forty-two wires, each of which is separately covered with solder mortar to prevent any local electrolytic action which might be set up between exposed copper and the other metals under the influence of moisture.

The Universal Maxometer.

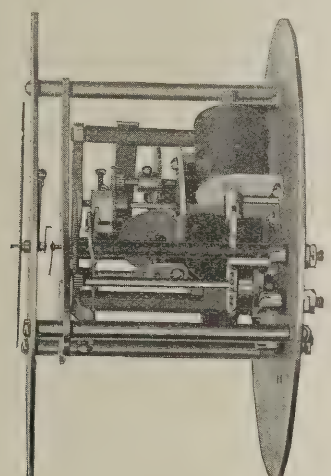
An instrument for indicating maximum demands, which may be used in connection with any make or type of watt hour meter was exhibited at the N. E. L. A. Seattle convention by the Minerallic Electric Co., of Chicago, and called the universal maxometer. It has been especially developed to satisfy the need for a maximum indicating device on loads under 50 H. P., which may be used with any watthour meter, exclusive of those to which the Maxicator is directly applicable. This instrument is interlocked electrically instead of mechanically with the meter, and is mounted in a separate case, connection to the meter being obtained through the use of two small wires.

A solenoid drives forward two pointers, the first being termed the "set back pointer" and the second the "friction indicating pointer." The set back pointer is in contact



Face of Maxometer.

with the friction pointer and during the forward motion will drive the friction pointer at exactly the same rate. At the end of the half-hour interval, however, the set back mechanism is released and automatically returns the first pointer to zero, the friction pointer remaining at its former position. The set back pointer, when it arrives at its first

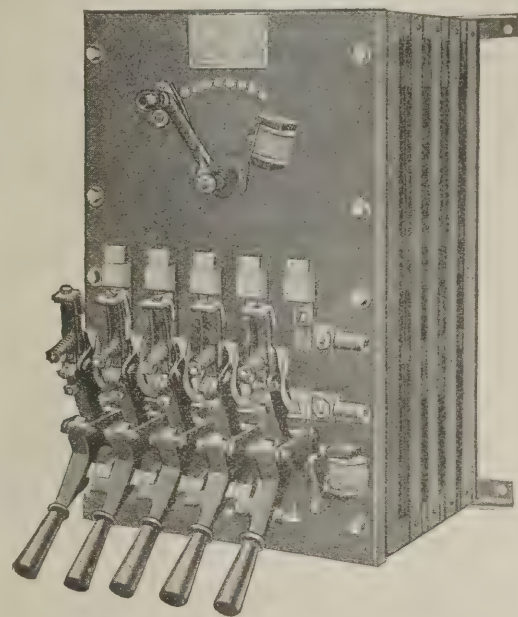


Internal View of Universal Maxometer

position, is again re-engaged with the advancing mechanism and travels forward exactly as before, being again set back at the end of a half hour. If the consumption of energy through the meter has been less in the second interval than in the first, the set back pointer will not move to the position of contact with the friction pointer, and will therefore not change its indication. If, however, the consumption has been greator, the friction pointer will be picked up and carried to a more advanced position, where it will again be left. The friction or indicating pointer, will, at the end of any time such as a week or month, thus indicate the maximum amount of travel of the set back pointer, which is the indication of the maximum demand.

New Combined Motor Starting and Speed Regulation Controller.

The Cutler-Hammer Manufacturing Co., of Milwaukee has placed on the market a new type of controller consisting of a multiple switch starter and a shunt field speed regulator. The starting portion is similar to the standard Cutler-Hammer multiple switch starter designed for use with large mortors or with motors of medium size when the starting conditions are severe. Each of the individual levers, when closed, cuts out a step of armature resistance bringing the motor up to normal speed. The field regulating rheostat mounted above, as shown in the illustration of a 50 H. P. 230 volt type, consists of a series of field resistance steps controlled by a single lever.



A Combined Motor Starting and Regulating Controller.

When the motor has been properly accelerated to normal speed by cutting out the armature resistance, the field regulating resistance may then be used to secure further increase in speed. If the main line switch is opened or the current supply interrupted, the no-voltage release on the starter opens the starting switches and this ,in turn, deenergies the no-voltage release of the field rheostat, causing the lever to return to the "full field" position. The motor is, therefore, protected against starting on weakened field or with a portion of the armature starting resistance short-circuited. Standard controllers of this type are made in sizes of 10 H. P. to 200 H. P. for 115, 230 and 500 volt circuits.

The Transpotarc.

The Fort Wayne Electric Works has lately developed the transpotarc which, as the name suggests, is a transformer for spot light arc lamps. The spot and flood lamps in general use in all well equipped theatres require a voltage of 35 volts at the arc, such voltage usually being obtained from the commercial A. C. lighting circuit supply of 110 or 220 volts, by the insertion of resistance in series with the lamp. The use of the resistance is not only wasteful of energy, but is a constant source of danger for the heat generated is liable to ignite the scenery and other inflammable materials on the stage. The transportarc has been designed to eliminate this fire risk and at the same time conserve the electrical energy formerly wasted as heat.

Transportarcs are rated at 1½ Kw. and are supplied

for service on either 110 or 220 volt, 60 or 133 cycle circuits. A point of special value is the fact that if the lamp terminals be short circuited the current will only rise to a small amount above normal. With the transportarc there can therefore be no dangerous flow of current under

THE TRANSPOTARC WITH A LENS LAMP.

any possible condition of service. Aside from the elimination of fire risk attendant upon the use of resistance with spot and flood lamps the transpotarc saves approximately 66⅔ per cent of the energy required to operate the lights with the old style resistance in series.

Irrigation Pumping Equipment.

A pumping outfit operated by 2200 volt induction motors and a small generating plant is now in successful operation on a 1,700 acre rice plantation near Crowley, La., and owned by Floyd Williams, of Ellis, La. The generating equipment consists of a 200 H. P. four cycle, quick start, slow speed Fairbanks-Morse Oil Engine runing on low grade oils, directly connected to a 170 Kva. 2,300 volt 3-phase, 60 cycle Fairbanks-Morse Alternator with exciter and switchboard.

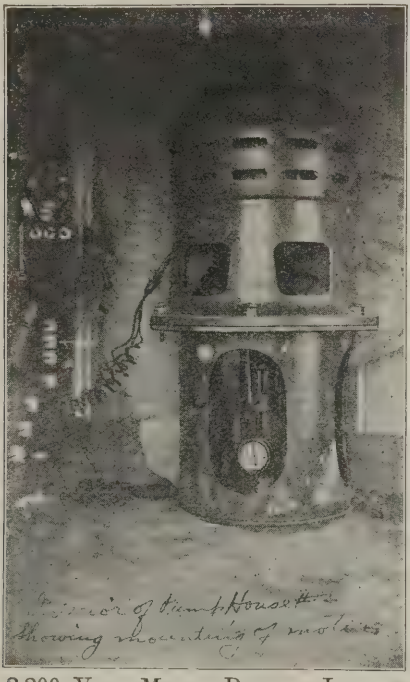


FIG. 1. 2,200 VOLT MOTOR DRIVING IRRIGATION PUMP.

The generating set provides current for operating three 75 H. P. vertical squirrel cage 2,200 volt motors direct connected to vertical centrifugal pumps. One pump is located at the power house, the second three quarters of a mile away, and the third a half mile further, or one and one quarter miles from the power house. The current is transmitted over private pole line on Mr. Williams property at 2,300 volts without transformers, excepting a small transformer at each pump house which provides 110 volt circuits for lighting the pump houses.

FIG. 2. GENERATING EQUIPMENT ON FLOYD WILLIAMS PLANTATION, CROWLEY, LA.

Each motor is connected by coupling to centrifugal pumps throwing 10 inch streams. The water stands in the wells from 40 to 60 feet below the surface, each pump discharging from 3,000 to 4,000 gallons of water per minute. Each well supplies about 250 acres. The equipment was sold and installed by Fairbanks, Morse & Co., No. 608 Magazine St., New Orleans, La.

The Surlock Socket.

The device shown here provides a locking feature to an electric light socket and has recently been brought out by the Pass and Seymour, Inc. of Solvay, N. Y. It is known as the "Shurlok" and affords protection to the lamps and reflector against theft.

THE SHURLOK WITH SEALING HOLES.

Some electric lighting companies have desired even greater protection as well as evidence that an attempt has been made to tamper with the lock, and this condition has been provided for in the following way. A small hole is drilled when desired and through the end of the fibre and the shell holding the lock. It will then be possible for the electric lighting company to pass a small wire through this hole and attach their private seal in the manner illustrated.

This will show at a glance whether any one has attempted to tamper with the lock, because it is impossible to insert the key until this private seal is destroyed.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

ATHENS. A contract has been awarded the Allen Engineering Co., of Memphis, Tenn., for two sets of Terry turbo-generators of 250 K. V. A. capacity. This equipment will be installed as part of the equipment for which $38,000 in bonds was recently voted.

ATTELLA. The city council has granted the Alabama Power & Development Co. a franchise to supply electricity for light and power in the city.

BIRMINGHAM. The Coosa River Electric Power Co. has plans for the construction of a hydro-electric plant at Lock No. 2 at Ten Island Shoals on the Coosa River. This plant will develop 25,000 H. P. and cost about two million dollars. The president of the company is Rosswell H. Cobb, of Gadsden, Ala.

BIRMINGHAM. The Kelly Street Railway Co. has petitioned the city commissioners to build an electric railway in Birmingham. D. C. Kelly and M. L. Miller are interested.

BIRMINGHAM. The Birmingham Railway, Light & Power Co. has made an official statement that one million dollars worth of improvements will be made to their equipment and underground distribution system. The improvements will include a horizontal turbine of 10,000 k. w. capacity and 400,000 feet of conduit for underground wires.

DECATUR. A hydro-electric plant will be developed at Clear Creek Falls, near Decatur, by Chicago capitalists.

DOTHAN. Bids will be received until noon of August 5th for installing electrical machinery including a 350 K. W. generator set complete. W. F. Thornton, Consulting Engineer of Birmingham, Ala., can give other information.

GUNTERSVILLE. J. B. McCrary & Co., of Atlanta, have been engaged to prepare plans for an electric light system.

HUNTSVILLE. A bid has been submitted to the city commissioners for lighting the city by the Electric Bond & Share Co. It is understood that the company is negotiating for the purchase of the system of the Huntsville, Chattanooga and Interurban Railway, Light & Power Co., and if the property is taken over will enlarge the plant. Electricity will be transmitted from the plant at Jackson Shoals on the Little River.

FORT PAYNE. The Little River Power Co., of Nashville, Tenn., has plans under way for the construction of three hydro-electric developments with a total output of 150,000 H. P. The first one will be built on the Little River near Fort Payne and 50,000 H. P. will be developed. Electrical energy will be generated at this place and transmitted to Anniston, Gadsden, Huntsville, and other localities.

LOUISVILLE. It is understood that the town is considering the installation of an electric lighting system.

MOBILE. The Southern Electric Co., of Mobile, has been awarded a contract for installing a lighting system for the Mobile & Ohio Railway Co., at Pier No. 3.

MONTGOMERY. The Montgomery Light & Power Co. has filed a notice of increase in capital stock from $1,000,000, to $2,000,000. It is understood that improvements will be made to the electric railway system.

FLORIDA.

ARCADIA. The DeSota Ice & Cold Storage Co. has been incorporated with a capital stock of $60,000. The president is R. King.

BARTOW. J. R. Davis and C. L. Wilson are preparing to organize a company for the purpose of establishing a fertilizer factory. The capital stock of the company will be $30,000.

BROOKSVILLE. The Brooksville Electric Light & Power Co. has made a contract with the Florida Power Co., at Ocala, for electric power from the plant of the latter company on Withlocoothee River, 25 miles below Dunnellon. The transmission line of the Florida Co. will be extended to the phosphate mines at Croom and from there to Brooksville.

HASTINGS. An electric light plant will be constructed and equipped at a cost of $10,000. Information as to contracts should be addressed to F. C. Buggee, of Hastings.

GEORGIA.

ABBEVILLE. The plant which was recently burned at a loss of $5,000, will be rebuilt. E. W. Mixon can give information.

ALBANY. The contract for the proposed ornamental lighting system has been awarded to the Albany Electrical Supply Co.

AMERICUS. The Americus Power Co. will erect a 400 H. P. steam power electric plant to cost approximately $50,000. J. B. McCrary Co., of Atlanta, are engineers in charge. The city council has accepted the bid of the Americus Power Co. for lighting the streets of the city and a new contract provides for 130 street lamps, of which 21 are to be flaming arcs and remainder tungsten. The cost will be $5,000 per year.

ATLANTA. The Atlanta & Macon Railway Co. has been incorporated with a capital stock of $100,000 for the purpose of building an electric railway between Atlanta and Macon. The incorporators are W. D. Seahan, Kennatt Cowan, S. Bullard, W. J. Massey, and James M. Brannen.

ATLANTA. The Central Georgia Transmission Co. has been granted permission to erect a power line from its substation in Atlanta to a sub-station to be built in East Point.

BLACKSHEAR. The city has voted $10,000 in bonds for the purpose of constructing an electric light system.

FORT OGLETHORPE. The contract for installing the electric lighting system at this point has been awarded to the W. M. Perry Electric Co., of Brooklyn, N. Y.

GREENSBORO. Plans are under way for the securing of electrical energy from the power plant of the Central Georgia Power Co., of Macon, Ga., from their plant on the Ocmulgee River.

HARTWELL. The vice-president of the Peoples Bank is planning a hydro-electric power plant to furnish electricity for light and power.

JENA. Plans are under way for the installation of an electric light and ice factory in Jena. The cost will be approximately $25,000, and H. W. Wright and C. C. O'Malley of Winfield, are interested.

MACON. The Georgia Railway & Power Co., of Atlanta, has been granted a franchise to erect transmission lines in Macon for the distribution of electricity for light and power.

MIDVILLE. The city council has engaged J. B. McCrary & Co., of Atlanta, to make improvements to the electric lighting system. A proposal for the installation of an electric lighting plant with sufficient output to supply 50 houses, ten stores and the street lighting is desired by Lewis Brown, Box 77, Savannah, Ga.

VALDOSTA. The Valdosta Lighting Co. has the approval of the railway commission to issue $365,000 in bonds and $185,000 in capital stock.

WEST POINT. The West Point Mfg. Co. is planning to install electric motor drive in its mill at Shawmut, Ga. It is understood further that the company has purchased a 2,000-K. W. turbine and generator with the necessary transformers for its steam plant at Langdale, Ala., to be used as an auxiliary to its present hydro-electric plant.

AUGUSTA. J. G. White & Company are the engineers and contractors retained by the Augusta-Aiken Railway and Electric Corporation, on the hydro-electric development at Stevens Creek, on the Savannah River, about nine miles northwest of Augusta, Georgia. The river at this point forms the boundary line between Georgia and South Carolina and is about 2,700 feet wide. The Charleston & Western Carolina Railway passes within 3.7 miles of the dam site and a spur connection will be made at a point about six miles from Augusta. The power house will be at the Georgia end of the dam, and for the ultimate installment its length will be about 360 feet. The length of the dam will be 2,300 feet, the spillway section of which will be about 2,000 feet long. A lock about 30 feet by 150 feet in the clear will be constructed for pole boat navigation. In the over-flow section of the dam adjacent to the power line will be five waste gates about 8 feet square. The average height of the dam will be 34 feet. Flash boards 3 or 4 feet high are to be provided. The ultimate installation will be 18,000 K. W. in ten main units, with two 200 K. W. water wheel driven exciter units and one 200 K. W. motor driven exciter. The average head will be 27.3 feet with extremes of 16 and 32 feet. The present installment will include 5 main and 2 exciter units. Transmission lines will be constructed to

Augusta, Georgia, ten miles, and from Augusta to Graniteville, S. C., 17 miles, making a total of 27 miles, to be operated at 33,000 volts. The generation voltage will be 2,300. This work will be completed early in 1914 and the cost will be about two and a half million dollars.

KENTUCKY.

BARBOURVILLE. The Dean Jelico Coal Co. will install an electrically operated mining plant on the Brush Creek. The cost will be approximately $40,000.

CLINTON. The Clinton Water & Light Co. has been incorporated with a capital stock of $15,000 by Thomas Emerson, J. L. V. Grenier and P. H. Porter.

LOUISVILLE. The Campbell Electric Co. has been incorporated with a capital stock of $50,000. The incorporators are H. L. Harry, T. B. Wilson, F. A. Noble and Isaac Milkewitch. It is understood that the company will take over the electric light plant recently purchased by H. M. Byllesby & Co., of Chicago, from Pike Campbell, of Louisville, for the price of $50,000.

TAYLORSVILLE. An ordinance creating an electric light franchise has been adopted and will be sold in the near future There are at present two bidders, Henry & Henry, and R. Beauchamp, both of whom are flour mill operators, and it is believed that they will install electrical machinery in their mill plants in the event the franchise is secured.

WILLIAMSBURG. H. M. Byllesby & Co., of Chicago, is planning the construction of a water power plant on the Cumberland River near Williamsburg.

MISSISSIPPI.

LOUISVILLE. An electric light plant is under consideration at this place. W. C. Height and J. L. McCicken are interested.

VICKSBURG. The electric utilities companies of Vicksburg have been purchased by I. C. Elston, Jr., and W. B. Walter, of Chicago. The new company will be known as the Vicksburg Light & Traction Co., and a new power house will be built. Three or four miles of track will also be laid and the plant generally rehibititated. W. B. Walter is president and I. C. Elston, Jr., is secretary, and the company incorporated with $1,000,000 capital stock.

NORTH CAROLINA.

CHARLOTTE. Bids will be received at the office of the supervising architect, treasury department, Washington, D. C., till August 2nd, for construction including plumbing, heating apparatus, gas piping, electric conduit and wiring and interior lighting fixtures for the remodeling, etc., of the United States post office and court house at Charlotte. Plans and specifications may be obtained at the office of James K. Taylor, supervising architect.

HENDERSONVILLE. The Laurel Park Street Railway is interested in the installation of a 150 H. P. steam plant to cost approximately $20,000.

MURPHY. The Carolina Tennessee Power Co. is proceeding with the plans for a development on the Hiawassee River after two years of preliminary engineering. The plans contemplate two developments, one near the State line between North Carolina and Tennessee and about 12 miles from the copper smelting industries of Ducktown, Tenn. The authorized capital stock is $5,000,000 with $250,000 issued.

SOUTH CAROLINA.

CLINTON. J. B. McCrary & Co., of Atlanta, has been secured as engineers by the city council to install a proposed power plant. The cost is estimated at $18,000.

COLUMBIA. E. W. Robertson, president of the Columbia Railway, Gas & Electric Co., and associates, have purchased the development which has been planned by the Power Shoals Power Co. on the Broad River about 25 miles from Columbia where a 25,000 H. P. plant will be developed. Surveys are now being made for the construction which includes a concrete dam 34 feet high and a power house. Tranmission lines will be erected from the power house to Columbia. J. G. White & Co., of New York, are the engineers.

SMITHFIELD. The city will construct an electric light plant and will receive bids until August 1st. G. C. White is engineer, of Charlotte, N. C.

TENNESSEE.

CHATTANOOGA. Dam site and surveys for right of ways for transmission lines are now being made by the Tennessee Hydro-Electric Co., which proposes to make developments on the Clinch and Power Rivers. A large dam and lock is to be located at Kingston above the point where the Emory River flows into the Clinch River. This company will supply electricity to Chattanooga, Knoxville, Nashville, and other small towns in Eastern Tennessee. J. S. Kunn, of Pittsburg, Pa., is interested.

CHATTANOOGA. M. B. Parker is in the market for a 50 K. W. generator and several motors ranging in size from five to twenty horse power.

GREENVILLE. The Tennessee Eastern Electric Co. has purchased the plant of the Greenville Electric Co. and the Watauga Electric Co. and the Johnson City Traction Co., of Johnson City, Tenn. The Tennessee Eastern Electric Co. is financed by Warren Tucker & Co., of Boston, Mass., and has applied for franchises in Morristown, Erwin, Jonesboro, and other cities in that section, planning to furnish electrical energy from a plant on Nolachucky River. Plans for the plants to be constructed are being prepared by New York engineers. It is further understood that the company plans to develop an interurban traction system in Eastern Tennessee to be operated from the hydro-electric plant.

KNOXVILLE. The Knoxville Railway & Light Co. has begun the erection of a new power house at Sixth Ave. and Southern Railway. The building will be of reinforced concrete and brick.

MEMPHIS. Plans are underway for the installation of an ornamental street lighting system on Madison ave.

MORRISTOWN. Water power sites in Eastern Tennessee will be developed by the Morristown Power & Development Co., in which J. Loop and W. C. Hale are interested.

NASHVILLE. The capital stock of the Anderson-Tubb Power Co., the Spartan Electric Light Co. and the Sparta Water Co. has been purchased by the Tennessee Power Co., of Nashville, Tenn., for a consideration of $85,000. These properties are made up of a 450 H. P. hydro-electric plant, lighting plant and water works and will become a part of the Tennessee Power Co., which controlls water power on the Ocoee River.

PARKVILLE. The Tennessee Power Co. has started work on a second development on the Ocoee River, ten miles above Parkville. A plant of 20,000 H. P. will be constructed and a high tension line connect this plant with the one now in operation at Parkville. Current will be stepped up to 110,000 volts and be distributed to Chattanooga, Nashville and the surrounding territories. H. M. Byllesby & Co. are engineers on this plant and are interested in the project financially.

RUSKIN. The Ruskin Cave College is in the market for a 35 K. W. generator, preferably second hand. Information can be secured further from R. I. Smith, the president.

BOOK REVIEWS.

ENGINEERING VALUATION OF PUBLIC UTILITIES AND FACTORIES, by Horatio A. Foster, author also of Foster's Electrical Engineer's Pocketbook. Published by D. Van Nostrand Co., New York. 361 pages, 50 blank forms. Price, $3.00.

The above work by one who has been for years an authority on electrical matters, measures up to the excellent standard of his previous works. As explained by the author in the preface, information has recently been in demand regarding valuation of public utilities due to the fact that in many states commissions are pointed having supervision of public utilities and require a valuation of properties when a desire is made to change rates or to add to the securities for any purpose. The work has therefore been made up with this idea in view giving complete information on the rendering of a valuation report such as would be required by the various commissions. That the information contained is of the highest type, reference need only be made to the fifteen years experience which the author has had in this work. Of particular value are the numerous forms which are presented, many of which are reproduced photographically from copies which have been developed and used by the engineering staff of the Wisconsin Railroad Commission and the Wisconsin Tax Commission. The subject of depreciation is thoroughly handled, and contains much information which will be of service to those who have even had much valuation work to do. The subjects of franchise, capitalization and control of public utilities are given considerable attention, important decision of courts being recorded.

This work is one which due to its original nature and individual characteristics will find a place in an engineering library however complete and be frequently referred to by manager and engineer alike. We recommend it in the highest terms. The following list of contents testifies further as to its excellent make up:

Value: Commercial; Economics; Physical; Intangible. Worth Present; Original Cost. Reproduction Value, New. Overhead Charges. Organization Expense. Legal Expense. Engineering. Interest. Taxes and Insurance. Brokerage and Discount. Scrap or Salvage Value. Wearing or Service Value. Remaining Service Value. Development Expense. Franchise Value. Going Concern. Good Will. Reports of Valuation. Values of Public Utilities Property. Direction for the Valuation of Tangible Property. Permanence of Valuation. Instructions for Valuation. Forms for Use in Evaluating Property. Forms for Tabulating Final Results. Valuation of: Real Estate; Buildings; Railroads; Street Railways; Water and Undeveloped Power Privilege; Damages to a Water Power Hydro-Electric Plant; Water-Works Property; Telephone Property; Electric Light Property; Gas Property; Manufacturing Property; Valuation Forms. Cost of Valuing a Property. Value of Good Will, Going Concern and Going Value. Depreciation in Factories; Railways; Definitions of Term or Classes of Depreciation. Obso-

lescence. Inadequacy and Supercession. Wear and Tear. Deferred Maintenance. Elements of. Rules on Depreciation in Great Britain. Metcalfe's Classification of Depreciation. Methods of Calculating. Rates of Depreciation. Renewals; Rules Laid Down by Chicago. Amortization: Definition; Of Capital; Of Patents. Depreciation Funds: Handling of; Reserves; In Wisconsin; In Nebraska; Abstracts from Court Decisions. Appreciation. Franchise: Definition; Term Franchises; Indeterminate; Abstracts of Court Decisions; Tax. Capitalization: Discussion; Abstracts from Court Decisions; Control of Public Utilities Properties. Lists of Public Service Commissions: State; Municipal. Court Decisions: Wilcox et al. vs. Consolidated Gas Company; City of Knoxville vs. Knoxville Water Company; National Water Works vs. Kansas City; Kennebec Water District vs. City of Waterville; Montgomery County vs. Schuylkill Bridge Company; San Diego Land and Farm Company vs. City of National City; Covington & L. Turnpike Road Company vs. Sanford et al.; Monongahela Navigation Company vs. United States; Cotting vs. Kansas City Stock Yards Company et al.; Smyth vs. Ames.

ELECTRICAL INJURIES, THEIR CAUSATION, PREVENTION AND TREATMENT, by Charles A. Lauffer. Published by John Wiley and Sons, New York. Price, 50 cents.

This small work contains information of value in the way of precautions leading to the prevention of electrical accidents and the treatment of many different injuries. It will be found useful by those companies who are now providing instruction to employees in first aid to injured.

MODERN ILLUMINATION, by Horstmann and Tousley. Published by Frederick J. Drake and Co., Chicago. Price, $2.00.

The rapid growth of illuminating engineering has created a demand for authoritative reference works on the subject. One such arranged in a compact, clean-cut, easily understood and thoroughly practically way is referred to above. It takes up the problems of modern illumination from the standpoints of architect, contractor and workman and gives the necessary data and principles for the planning and installing correctly designed illuminating systems. A feature of the work is the complete information on all kinds of illuminants. Besides giving the voltage, candlepower and general characteristic the advantages and disadvantages are pointed out in a way that the merits of the different units can be compared for any particular service. This work will be found valuable by all interested in illumination and well worth the price.

THE MATHEMATICS OF APPLIED ELECTRICITY, by Ernest H. Koch, Jr. Published by John Wiley and Sons, New York City. 634 pages, and many diagrams, curves, circuit and vector diagrams. Price, $3.00 net.

This work is the first of its kind for in every respect it carries out the impression gained from its name, in a thoroughly practical way. It is one that the practical man with only a grounding in elementary mathematics need not be scared of for if he has a clear understanding of the practical operating conditions, he will find it an inspiration and a means of securing a pencil and paper interpretation and picture of electrical troubles and relations. The volume has been conceived by one who thoroughly appreciates the problems practical electrical engineers meet and has presented the mathematical side of so many general and special cases that almost any difficulty can be solved through a careful study of the relations. The work is not an encyclopedia of electrical phenomena, yet the fundamental principles underlying all electrical problems are given in such a way that their study gives to the practical man the ability to interpret and formulate his difficulties, the one great desire of the careful, thoughtful engineer.

The contents of the work speak for the nature of the work which is divided into three parts: I The Transformation and Interpretation of Formulas. Direct Current Problems. II The Graphs of Formulas and the Formation of Graphs. III Vectors and Vector Diagrams, Alternating Current Problems.

DESIGN OF ELECTRICAL MACHINERY. Volume II. Alternating Current Transformers. By William T. Ryan, E. E. Published by John Wiley and Sons, New York City. 119 pages. Profusely illustrated. Price, $1.50 net.

In this the second volume of the work by Prof. Ryan on the design of electrical machinery, the same thorough treatment has been given the design of transformers as was given direct current dynamos in volume one. No superfluous details are given, from cover to cover is presented as clearly and briefly as possible the fundamental principles upon which design rests. It is a practical work and one which every designer should have. It contains the following chapters: I. Development of A. C. Transformers. 2. Varieties of Transformers and their Characteristics. 3. Method of Designing Constant Potential A. C. Transformers. 4. Illustrative Designs.

TESTING, FAULT LOCATION AND GENERAL HINTS FOR WIREMEN. By J. Wright. Published by D. Van Nostrand Company, New York. 85 pages, bound in cloth. Price, 50 cents.

Arranged for ready reference the author has in this work presented many tests and hints for locating trouble in electrical apparatus and systems. The tests are such that they can be performed by the average electrician and do not require complex or expensive apparatus.

MODERN INDUSTRIAL LIGHTING. Published by the Commercial Section of the National Electric Light Association.

At about the time of the Seattle convention the Commercial Section of the National Electric Light Association published a 64 page publication called Modern Industrial Lighting. This book is divided into three main parts taking up, The Arguments in Favor of Good Lighting; The Design of Industrial Lighting Installation, and Industrial Lighting Practice. It is practical throughout and mainly non-technical, being especially written to interest central station solicitors, and the managers of factories and other plants where illumination is an important consideration. Many diagrams and tables are given and the material is presented in such a way that it forms complete information in regard the lighting requirements and the necessary arrangements to secure proper illumination in various installations.

At about the same time the Commercial Section issued another booklet entitled "Ornamental Street Lighting." This contains the arguments in favor of decorative lighting and in general descriptions of various systems and their cost. It is well illustrated and contains 48 pages.

Another little publication is entitled "Electric Service in The Home," and takes up in three chapters the following subjects: Wiring of the Home; The Lighting Equipment and Electrical Devices. The material presented is mainly of an educational nature and will found a useful help by solicitors in talking to various parties interested in installing wiring in both new and old houses.

PERSONALS.

MR. J. W. FRASER, who sailed for Manchester, England, April 15 of this year to take charge of hydro-electric work for the British Westinghouse Electric and Mfg. Co., has left that place for Tasmania. Here he will build a hydro-electric plant and transmission system. His address is care of Hydro-Electric Power and Metallurgical Co., Hobart, Tasmania.

MR. J. J. SMITH, general manager of the Baltimore Electrical Supply Company of Atlanta, advises that Southern electrical supply business seems to have suffered no serious set back thus far from conditions that are usually responsible for poor business during a presidential year. The Atlanta branch was opened early in March of this year and business has gradually increased in a manner which has passed expectations. Mr. Smith reports a nice order from the Georgia Railway and Power Company of Atlanta, covering electrical supplies for the Tallulah plant of the company now under construction. This development will be one of the largest in the country and possesses many interesting engineering features.

HACKETT AND MORA of Philadelphia, have been retained as consulting engineers by the Cruse-Kemper Company of that place. This company plans extensive improvements in their power plant and shops.

J. L. CRIDER, formerly with the Baltimore & Ohio Railroad Company and Chief Engineer of the New York, West Chester & Boston Railroad, has been engaged by J. G. White & Company, Inc., as construction superintendent on the Oakland, Antioch & Eastern Railway, which is an extension of the Oakland & Antioch Railway.

FORD, BACON & DAVIS, Engineers, New York, announce that Charles F. Uebelacker, Charles N. Black and William von Phul have been admitted to partnership. To the engineering profession these men are well known through their records of the past twenty years. The policy of the firm will continue as in the past, in the efforts to improve the standards of construction and to increase the efficiency of the operation of the properties entrusted to its charge, through the personal attention of its partners. The firm of Ford, Bacon & Davis was established in 1894, and has in its service an experienced organization. With the new partners it is in a postion to materially extend its present engineering and management facilities for investigations and reports, and for the design, construction and operation of public utility and engineering enterprises generally. The principal branch offices of the firm at 921 Canal Street, New Orleans, and 85 Second Street, San Francisco, will each be in charge of a resident partner.

OBITUARY.

MR. ANDREW E. STEVENS, manager of the Consumers Power Company, Minot, North Dakota, met death Saturday, June 22nd in an automobile accident in which his wife was

also severely injured. Mr. Stevens was born in Rushford, Minn., February 7, 1869. He was educated in the public schools of Winona, Minn., and in the University of Minnesota, Minneapolis, Minn. Mr. Stevens had been in the employ of H. M. Byllesby & Company since January, 1911. Before entering the service of Byllesby & Company he had had several years experience in shop and street railway work in Minneapolis and St. Paul. He also had been manager of several telephon exchanges for the Wisconsin Telephone Company, and for several years prior to engaging with Byllesby & Company had served on the sales force of the Fort Wayne Electric Works, Chicago office. Mr. Stevens was a member of the Beta Theta Pi Fraternity. In Minot he was an active member of the Commercial, Elks and Minot Gun Clubs. He was married to Miss Emma Howard and is survived by her and one son, fourteen years old.

ARTHUR J. MORGAN, Secretary of the National X-Ray Reflector Company, Chicago, died July 5th, of pneumonia, at his residence in Evanston. He was born in Los Angeles, California, in 1873, and came to Chicago in 1900. He was a member of the Illuminating Engineering Society, Chicago Brass Manufacturers' Association, Chicago Association of Commerce, etc., etc. As a member of the Illuminating Engineering Society, and through his business connections, he had much to do with the recent advance developments in illuminating methods. Mr. Morgan leaves a wife and two small children, his mother and two sisters, a large number of friends to mourn his untimely departure.

INDUSTRIAL ITEMS.

THE WESTERN ELECTRIC COMPANY'S returns for June complete the first half calendar and fiscal year for the Western Electric Company. Total of goods billed out during that period run surprisingly close to the company's official estimate, made when the year was not two months old and which was that 1912 would show a total of approximately the same as 1911's total of $66,000,000 gross business. Goods billed out during June were 10 per cent. more than for that month a year ago, which makes this year's six months aggregate of gross sales 2 per cent. ahead of the corresponding six months in 1911. The 10 per cent. increase for June is like the abnormal increase of 17 per cent. shown in April, and is due to special circumstances. It does not mean that affairs are improving as rapidly as indicated by last month's returns, the six months total being a better criterion of how the Western Electric is progressing. Fluctuations by months in the company's business have been considerable this year to date. January and February were respectively 9 per cent. and 2 per cent. behind the same months in 1911, March ran about even with the preceding March, April showed a gain of 17 per cent., May a falling off of 3 per cent. and June an increase of 10 per cent. The gain last month, came mostly from America and was widely distributed, so that it cannot be attributed to special conditions prevailing in any one section of the country.

THE MONARCH INCANDESCENT LAMP WORKS of General Electric Company have moved their offices from 900 Wabash Avenue to 1109 Manhattan Bldg., Chicago.

THE SMITHFIELD GARAGE AND MACHINE CO., Smithfield, N. C., has been awarded the contract for plumbing and wiring of the new school building of Smithfield. The contract amounts to about $1,800.

PASS AND SEYMOUR, INC., Solvay, N. Y., announce the opening of an office at Rialto Bldg., Room 914, corner of Mission and New Montgomery Sts., San Francisco, Cal. This office will be in charge of W. Brewster Hall and through it the business for that section of the country will be handled.

THE WESTERN ELECTRIC CO. has recently contracted to make improvements to their Lee Street warehouse at Atlanta. A total area of 3,700 square yards of concrete flooring will be laid in the warehouse and cable yards. The work will be done by the Southern Engineering Company, Mr. Theo Langenbergh, manager, Grant Bldg., Atlanta. About $4,000 will be expended in this improvement which will give the company one of the most up-to-date warehouses in the South.

AUTOMATIC PRESS CONTROL. The Monitor Controlling Company, of Baltimore, has issued a bulletin dealing with the subject of automatic control for printing presses and the various machines used in the allied trades. Such devices as those dealt with should greatly increase the efficiency of the press room, owing to the time saved in the control of the press and in saving in wear and tear on the machines. A perusal of the pages of the bulletin will affford the opportunity of becoming acquainted witL the most recent types of apparatus developed for the automatic control of printing presses and the like.

Alphabetical Index to Advertisers.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

Cabinets.

BISSELL COMPANY F., 226-230 Huron St., Toledo, Ohio. Security cabinets and boxes. All metal cabinets with tubs formed of one sheet for panel boards, switches and cut-outs. Approved June 14, 1912.

CLEVELAND SWITCHBOARD CO., 430 Prospect Ave., N. W. Cleveland, Ohio. Wood or steel cabinets lined with slate or steel for panelboards, switches or cut-outs. Approved June 14, 1912.

COMMERCIAL ELECTRIC CO., 728-730 Prydas St., New Orleans, La. Sheet metal cabinets for switches, cut-outs and panelboards. Approved June 14, 1912.

CONSOLIDATED SHEET METAL WORKS, Milwaukee, Wis. Sheet steel cabinets formed out of one piece of metal, with sheet steel doors. Approved Jun 14, 1912.

CUTHBERT ELECTRICAL MFG. CO., 105-109 S. Clinton St., Chicago, Ill. "Cuthbert" panelboard cabinets, lines, steel cabinets, wood cabinets with steel or slate lining, and wood cabinets with asbestos lining. Approved June 14, 1912.

ELECTRIC MANUFACTURING CO., 926-940 LaFayette St., New Orleans, La. Steel panelboard cabinets, also pressed steel boxes for service entrance switches. Approved June 14, 1912.

ELECTRICAL MFG. CO., 1363 W. Second St., Cleveland, Ohio. "E. M. Co." steel panelboard cabinets with steel trim and doors. Approved June 14, 1912.

GENERAL ELECTRIC CO., Schenectady, N. Y. "G. E." metal with wooden doors and trims. Approved June 14, 1912.

J. P. MFG. CO., Niverville, N. Y. Steel cabinets formed out of one piece of metal and with sheet steel doors. Approved June 14, 1912.

KRANTZ MFG. CO., H. T., 160-166 Seventh St., Brooklyn, N. Y. "Krantz" panelboard cabinets of wood, metal lined or of steel. Approved June 14, 1912.

LEMLEY, WEB A., 936 Union St., New Orleans, La. Sheet metal cabinets for enclosing switches and cut-outs. Approved June 14, 1912.

LEONARY-BUNDY ELECTRIC CO., Cleveland, Ohio. "L. B. E. Co." steel cabinets for panelboards, cut-outs and switches. Approved June 14, 1912.

METROPOLITAN ELECTRIC MFG. CO., East Ave. and 14th St., Long Island City, N. Y. Steel and wooden cabinets for panelboards or switches. Approved June 14, 1912.

MILWAUKEE VAULT & ELECTRIC CABINET BOX CO., 521-523 Market St., Milwaukee, Wis. Steel cabinets for panelboards and switches. Approved June 14, 1912.

NATIONAL METAL MOLDING CO., Fulton Bldg., Pittsburg, Pa. "National" pressed steel sherardized cabinets, built up of parts. Approved June 14, 1912.

PAISTE COMPANY, H. T., 32nd and Arch St., Phila, Pa. Sheet metal and cast iron cabinets. Approved June 14, 1912.

PIKE ELECTRIC MFG. CO., 6-10 Central Ave., Minneapolis, Minn. Pike sheet metal panelboard cabinets. Approved June 14, 1912.

ROCHESTER SWITCHBOARD CO., 5 Prospect St. Rochester, N. Y. Sheet metal panelboard cabinets with slate linings. Approved June 14, 1912.

ROHN, GEO. F., 446 East Water St., Milwaukee, Wis. Sheet metal cabinets for cut-outs and switches. Approved June 14, 1912.

SCHMIDT ELECTRIC CO., A. R., 137 Oneida St., Milwaukee, Wis. Steel cabinets for panelboards and switches. Approved June 14, 1912.

STAR METAL BOX CO., 201 Fulton St., N. Y. Pressed steel cabinets for switches and cut-outs. Approved June 14, 1912.

WORCESTER ELECTRIC MFG. CO., 42 LaGrange St., Worcester, Mass. "Worcester" panelboard cabinets, steel and wooden boxes, slate and steel lined. Approved June 14, 1912.

WURDOCK ELECTRIC MFG. CO., 195 Eleventh St., St. Louis, Mo. "Wurdock" built-up and formed steel cabinets. Approved June 14, 1912.

YOUNG, G. H., Elmira, N. Y. Metal cabinets for open or concealed work built up of steel plate. Approved June 14, 1912.

Flexible Cord.

BAY STATE INSULATED WIRE AND CABLE CO., River St., Hyde Park, Mass. Marking: One black thread under the braid parallel with the rubber. Approved May 20, 1912.

Fixtures.

AMERICAN REFLECTOR AND LIGHTING CO., 517 W. Jackson Bldg., Chicago, Ill. Tungsten window reflectors. Approved June 18, 1912.

BENJAMIN ELECTRIC MFG. CO., 120-128 S. Sangamow St., Chicago, Ill. Tungsten arcs, ceiling fixtures, reflector socket fixtures and series connected cluster. Approved June 18, 1912.

CHICAGO GAS AND ELECTRIC FIXTURE CO., 124 N. Jefferson St., Chicago, Ill. Electric and combination fixtures. Approved June 18, 1912.

CHICAGO MINIATURE LAMP WORKS, 2110 S. Halsted St., Chicago, Ill. Incandescent lamp fixture of individual letters mounted on porcelain vases, having receptacle and plug contacts for forming various words. Each letter takes 1-10 ampere at 110 volts. Approved June 18, 1912.

THE DALE COMPANY, 9th Ave., 13th and Hudson St., New York. Ceiling receptacle and canopy for use with one light. Approved June 18, 1912.

ERICKSON ELECTRIC CO., L., 82 Sudbury St., Boston, Mass. Fixture for show case and show window. Approved June 18, 1912.

FARIES MFG. CO., Decatur, Ill. Portable fixtures, Approved June 18, 1912.

FEDERAL ELECTRIC CO., Lake and Desplaines Sts., Chicago, Ill. Indoor and outdoor lamp clusters. Approved June 18, 1912.

GIESE MFG. CO., 260 S. Fifth Ave., Phila, Pa. Electric and combination fixtures. Approved June 18, 1912.

HILL COMPANY, T. D., 2314-2318 N. 8th St., Phila, Pa. Adjustable stem for fixtures. Approved June 18, 1912.

HORN AND BREMEN MFG. CO., 427-433 N. Broad St., Phila, Pa. Electric and combination fixtures. Approved June 18, 1912.

Fuses—Cartridge Enclosed.

BRINES ELECTRIC CO., 811-813 N. Second St., St. Louis, Mo. "St. Louis" enclosed cartridge fuses 600 and 250 volts all capacities. Approved June 4, 1912.

ALCOVICH & SON, HERRMAN, 625 Market St., San Francisco, Cal. Refillable type, 250 and 600 volts, all capacities. Approved June 7, 1912.

WILLETT, GEO. R., Pittsburg, Pa. Refillable type, 250 and 600 volts, 0-60 amperes. Approved June 6, 1912.

Vacuum Cleaners.

MONARCH VACUUM CLEANER CO., 1151 Broadway, New York City. "Monarch" vacuum cleaner and renovater. Approved June 22, 1912.

Receptacles, Standard.

BRYANT ELECTRIC CO., Bridgeport, Conn. "Bryant New Wrinkle" wall sockets having cleat bases. Approved June 13, 1912.

PERKINS ELECTRIC SWITCH MFG. CO., Bridegeport, Conn. "Perkins" brass shell wall sockets. Approved June 13, 1912.

Signs, Electric.

A. & W. ELECTRIC SIGN CO., Prospect and W. 3rd St., Cleveland, Ohio. All-metal signs. Approved June 19, 1912.

COLONIAL SIGN & INSULATOR CO., Akron, Ohio. Porcelain letters for mounting on frames. Approved June 25, 1912.

ELECTRIC MFG. CO., 926-940 LaFayette St., New Orleans, La. Sheet metal signs. Individual letter and panel type. Approved June 19, 1912.

FEDERAL ELECTRIC CO., 640 W. Lake St., Chicago, Ill. Panel and sectional types. Approved June 19, 1912.

FLEXLUME SIGN CO., 1453 Niagara St., Buffalo, N. Y. Signs of sheet metal with letters of solid molded gloss illuminated by lamps inside the case. Approved June 19, 1912.

VALENTINE ELECTRIC SIGN CO., 20 N. California Ave., Atlantic City, N. J. Closed sheet metal boxes each forming a single letter for sign work. Approved June 19, 1912.

POSITIONS WANTED.

The rate for "Positions Wanted" and "Help Wanted" advertisements of 40 words or less is one dollar an insertion; additional words, two cents each, payable in advance. Remittances and copy should reach this office not later than the twentieth of the month.

Replies may be sent in care of SOUTHERN ELECTRICIAN, Atlanta, Ga.

WANTED..Position as Manager or Superintendent of Manufacturing Plant employing 200 or more men. Prefer plant having machine shop, pattern shop and foundry. Well up in modern methods of production at low cost and can produce results. Best of references. Address Box 7, Southern Electrician.

POSITIONS VACANT.

SALESMAN WANTED A first-class motor salesman wanted for Atlanta. Guaranteed salary and expenses. Must be experienced and have good references. Address Box 14, Southern Electrician.

USED MACHINERY FOR SALE.

STEEL WASTE PAPER BALING PRESS making 300-pound bales; new and unused; also steel portable elevator for lifting and piling heavy bales and boxes; new and unused; bargains for quick sales. Address, H. N. M., care **Southern Electrician.**

FOR SALE An Electric Light Plant on a paying basis in a growing North Carolina town. Good proposition for any one with about $5000.00. Owner has other business. Address "W," Care of Southern Electrician.

FOR SALE

1 complete 600-light Plant, $350.
1 complete 1200-light Plant, $500.
Large stock of Engineers, Pumps, Air compressors, all in A-1 condition.
35 H. P. Boilers at $175.
Railroad Rails, 16-lb. to 70-lb.
Pipe from 1" to 12".
Address Box 32, Southern Electrician.

FOR SALE Meitz & Weiss gas engine with pump gear. Two and one-half horsepower. New and unused. Weight 1,500 lbs. This engine is built by one of the oldest and best known gas engine builders in America; hundreds in use for operating small lighting plants for yachts and everywhere that reliability and steady running is required. Hot ball ignition and may be operated with crude oil. Cost $250. Will sell for $100 cash. Satisfaction guaranteed or money refunded. F. K. Houston, 1021 Grant Bldg., Atlanta, Ga.

WANTED TO BUY Telephone exchange with not less than 125 or more than 400 subscribers within the city limits. Make me your cash price, giving information in detail. Address Box 177, Union Springs, Ala.

Central Station Equipment.

At special low prices, complete list of station equipment for sale, including boilers, engines, pumps, heaters, 220 volt D. C., 1100 volt A. C. generators, direct connected and belt connected; switch boards, A. C. and D. C.; large list of D. C. 220 volt motors.
Address
Box 38 Southern Electrician.

Electric Light or Power Plant.

Fairbanks-Morse 50 horse-power Producer Gas, like new, cheap.
Address
Box 40 Southern Electrician.

Engines and Generators

FOR SALE—BARGAIN

One 150 K. W. Engine, Generator Unit.
One 100 H. P. Engine.
One 45 H. P. Engine.
One 25 K. W. Lighting Generator.

The Griswold Mfg. Co., Erie, Pa.

MACHINERY BARGAINS.

CORLISS ENGINES.

18x42 Lane & Bodley, R. H.
14x36 Bates, R. H.
10x24 Lone Star, R. H.

FOUR VALVE AUTOMATIC ENGINES.

14x20 Russell, L. H.
13x20 Russell, R. H.
13x18 Atlas, R. H.

AUTOMATIC ENGINES.

16x18 Ames, R. H.
14x24 Armington & Sims, R. H.
14x20 Atlas, L. H.
14x16 Atlas Center Crank.
13x12 Chuse Center Crank Self Oiling.
12x18 Atlas, R. H.
12x12 Ideal Center Crank Self Oiling.
11x16 Houston, Stanwood & Gamble, L. H.
11x16 Atlas, R. H.
11x16 Frost, R. H.
10x16 Atlas, L. H.
10x12 Russell, R. H.

THROTTLING ENGINES.

16x24 Brownell, R. H.
14x20 Brownell, R. H.
14x20 Atlas, R. H.
13x18 Frost, L. H.
13x18 Continental, L. H.
13x16 Erie Center Crank.
13x16 Atlas Center Crank.
12x24 Atlas, L. H.
12x16 Chandler & Taylor, L. H.
12x16 D. June, L. H.
11x16 Atlas, R. H.
11x16 Brownell, L. H.
11x16 Ames, R. H.
11x15 Erie City Center Crank.
10x15 Erie City Center Crank.
10x16 Frost, L. H.
10x12 Skinner Center Crank.
10x12 Ames, R. H.
9x12 Ames, L. H.
8x12 Atlas, R. H.
7x10 Bay State Center Crank.
6H. P. Vertical.
3H. P. Vertical.

BOILERS.

2..72x18 High Pressure.
1..72x16 High Pressure.
2..66x16 Standard.
4..60x16 Standard.
1..60x14 Standard.
4..54x16 Standard.
4..54x14 Standard.

Good assortment of smaller sizes from 20 H. P. to 50 H. P., including vertical boilers from 2 H. P. to 15 H. P.
Address Box 30, Southern Electrician.

SOUTHERN ELECTRICIAN

PUBLISHED MONTHLY

Vol. 44. SEPTEMBER, 1912 No. 9

ADDRESS COMMUNICATIONS TO

SOUTHERN ELECTRICIAN

GRANT BUILDING

ATLANTA, GA. U. S. A.

D. H. BRAYMER, Editor.

A. G. RAKESTRAW, H. H. KELLEY, F. C. MYERS, L. L. ARNOLD — Associate Editors.

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Foreign ---------- $1.50 Per Year

Complaints of failure to receive SOUTHERN ELECTRICIAN regularly or of errors of any nature relating to subscriptions should be promptly made to the publication office in Atlanta.

Advertising copy for SOUTHERN ELECTRICIAN or change orders for standing advertisements must reach Atlanta by the 5th of the month preceding the month of publication.

Entered at Atlanta Postoffice as Second-class Matter.

CONTENTS.

1,000,000 Horsepower to be Developed By Five New and Projected Southern Systems.

In another section of this issue appears a description of a Georgia hydro-electric development and the system of which it is a part. The operation of this system opens a new chapter in Southern electrical development particularly in the state of Georgia. We refer to the Tallulah Falls development of the Georgia Railway & Power Co., which with the exception of the immense development of 300,000 horsepower at Keokuk, Iowa, by the Mississippi River Power Co., is the largest single plant located east of the Rockies and further, operates under the highest head, namely, that of 600 feet. High head developments in the South are not the ordinary type, principally on account of the fact that where high heads are available, the stream flow is small, or the cost of such a development is beyond a commercial possibility.

The design of the plant under consideration however, located at a point which has long been called "The Niagara of the South," possesses distinct features. These features include storage facilities, available head and a water way from the power dam to the turbine wheels, approximated by no plant in operation in the South at the present time and only in a small degree by one that is projected. This is the second development of the Tennessee Power Company where above the development placed in operation by the Eastern Tennessee Power Co., on the Ocoee River, a development will be constructed which by a dam and tunnel through the mountain side will make available a head of 500 feet and render possible the development of 60,000 horsepower. The erection of a plant of this size at this time in the South creates little surprise and only casual mention, yet it is within the memory range of a large majority of our readers that Southern hydro-electric development in large capacity was born. In fact our first plants are yet very young, those of a capacity of over 15,000 horsepower being not more than five years old. Seventeen years ago marks the beginning of electrical transmission in the South, and at the moderate voltage of 5,500. Today sees the largest transmission system operating well toward the top notch of present transmission voltage, located in the South and the possibilities of the field for equally extensive systems just opened.

The activity now going on in the state of Georgia in hydro-electric development and high tension transmission is only a part of an immense work underway and laid out for the entire Piedmont region. The plants to be finished and those to be soon underway, include those of the Tennessee Power Company aggregating 170,000 horsepower, the Hales Bar Development of the Chattanooga and Tennessee Rivers Power Company, where a dam across the river renders available 60,000 horsepower, the five dams and plants of the Tennessee Hydro-Electric Company with plans for the development of 275,000 horsepower in the states of Tennesse and Virginia, the extensive system of the Aluminum Company of America, which through a chain of dams on the Little Tennessee River and tributaries,

will harness 400,000 horsepower by water power developments within a radius of 100 miles in Eastern Tennessee and Western North Carolina. Neglecting the many other plants of less than 10,000 horsepower, there is represented in the developments mentioned a probable possibility of approximately 1,000,000 electrical horsepower being available in addition to that now developed in the South in the next three years for exploiting the industries now already formed and creating others for which the section is excellently suited.

The progress that we have already witnessed in hydroelectric power engineering and the advances which are directly attributable to it, is only an indication of the advances to be made during the next 25 years. The cheapness of water power already developed has in a large measure been responsible for the remarkable industrial development of the South thus far, and this progress has now reached the point where it is reacting to stimulate the control of Southern water powers and the transmission of that power through electrical energy to the remotest towns and cities where the possibilities are yet lying dormant. This reaction has been assisted by a peculiar chain of political circumstances, important among which is the checking of the Western section of the country through the so called conservation movement. The capital therefore naturally interested in water power projects has been diverted to the Southern states where conservation is best interpreted by making developments instead of preventing them. This advantage will remain with the South until Federal authorities decide upon terms for reopening of Western lands upon a basis that will attract capital.

Usefulness of Motor Drive Data.

The engineering arguments for the electric drive in connection with industrial operations are now well known and the conditions which tend toward economy and efficiency generally recognized when compared with certain other conditions in the average mechanically operated plant where expert attention is not given to transmission details. The actual data that has been collected from those plants that have changed to electric drive has in the hands of the capable engineer thrown much light on production costs. Such data has provided a reliable basis of reference for changes in transmission details of other plants and helped to draw sharper lines between the conditions where the outlay in motors is advisable as against repairs or additions to an already existing mechanical equipment, for not all such equipments under all circumstances are bad or decidedly uneconomical.

Comparative costs of operation of this nature are shown in a certain textile mill when an addition was made and electric drive installed to operate 35 web looms averaging 40 shuttles each and used to produce elastic webbing. In the old plant still operating there are 24 looms averaging 29 shuttles each. While in the new plant there are practically twice as many shuttles as in the old, the cost of running is about half the present cost of running the old plant where gas fired boilers and steam engines with the usual belt and shafting transmission is used. The average bill for power current during three months has been $46 per month while the gas for the old plant was $43 per month. To this must be added $30 for extra engineer's service over that of new plant and $5 for water, oil and waste, making a total of $32 per month over the operating cost of the new addition with twice the shuttles.

These results would be considered interesting if not remarkable even when comparing a steam plant using coal at $2.50 per ton with an electrically driven plant. They are still more so however when it is considered that the boilers in the plant are fired with natural gas at 10 cents per thousand cubic feet. While the actual operating costs are in decided contrast, another feature is noticeable in regard to output of the two halves of the plant, a feature which it is difficult to get exact data on except by accurately kept data of operating conditions and work. With these factors carefully looked after, it was found that the output ratio of the two equipments was greater than two to one, due to the fact that the motor driven looms were run at least ten percent faster than those of the old mill.

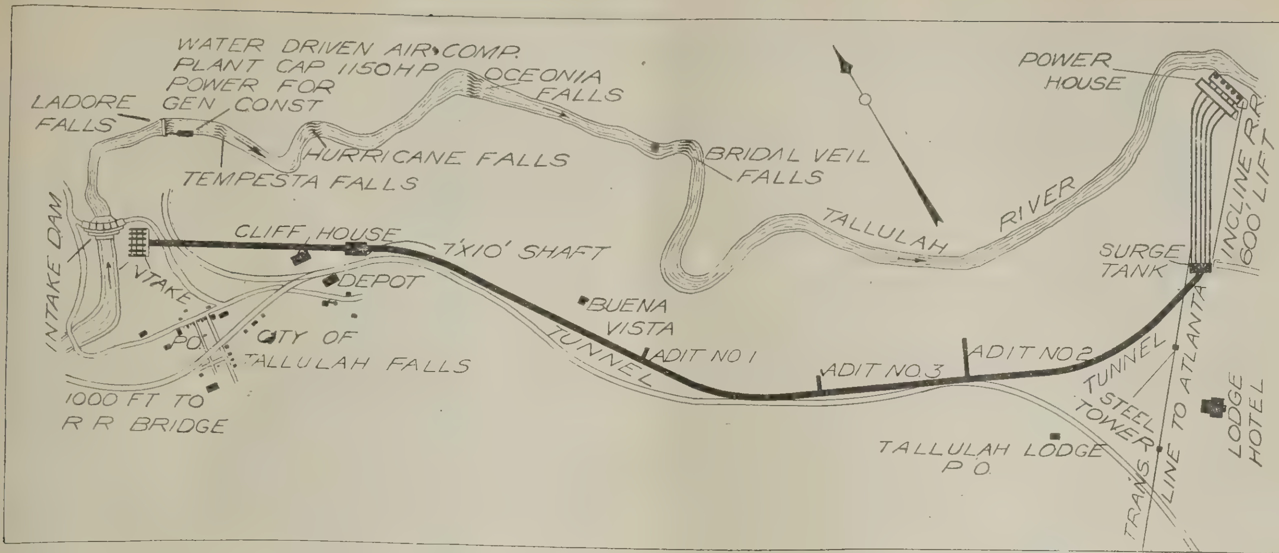
While this is a particular case in a particular industry, it shows the engineering, operating and common sense conditions that must be taken into consideration when planning any nature of transmission system for an industrial plant. Not every case will show up as strongly in contrast as this one and in such cases the responsibility placed upon the engineer in rendering a decision can only be felt when he is thoroughly familiar with facts, factors, and costs in the field in which he is called to work.

The Boiler and Furnace Problem.

The United States Bureau of Mines makes the statement in a bulletin just issued that the present steaming capacities of steam boilers can be tripled or quadrupled by forcing over the heating surfaces three or four times the weight of gases now passed over them. "With well-designed mechanical-draft apparatus this greater weight of gases can be forced through the boilers at small operating cost," the bulletin states. "It is possible to increase the capacity of many of the present boilers in this way without reducing their efficiency much; in fact by proper arrangement of the heating surfaces the efficiency can be made higher than the present rating. The efficiency of any boiler can be increased by arranging its heating surfaces in series with respect to the path of hot gases. New boilers of high efficiency can be constructed by making the cross section of the gas passages small in comparison with the length."

These statements are contained in Bulletin 18, entitled the Transmission of Heat into Steam Boilers, the authors being Henry Kreisinger and Walter T. Ray. The investigation of the transmission of heat into steam boilers is one of several researches now being carried on by the Bureau of Mines that have for their object the testing of methods by which our mineral fuels may be used more efficiently.

It has of late been shown, and the investigation referred to confirms the fact, that the principles governing the combustion of fuel in boiler furnaces and the absorption of heat by boilers have been little understood. The dogmas that the area of grate should have a certain ratio to the area of the heating surface, and that it takes 10 square feet of heating surface to make one boiler horsepower, seemingly had become so thoroughly fixed in the mind that they were hardly ever questioned. It is only within the last decade that a few engineers have broken away from the old rule of thumb methods and have begun to investigate the functions of the boiler and furnace separately. Their studies seem to mark the beginning of advance in steam-generating apparatus.



Tallulah Falls Hydro-Electric Development of Georgia Railway and Power Company

(*Written Exclusively for* SOUTHERN ELECTRICIAN.)

BY D. H. BRAYMER.

A Description of the Largest Hydro-Electric Plant in the South—90,000 Horsepower Output.

IN WHAT follows a brief outline and description will be given of the construction work on the Tallulah Falls development of the Georgia Railway & Power Company at Tallulah Falls, Ga., as well as the general plans and arrangements of the final project and the system of which it is a part. At a later time when this plant is placed in operation, the engineering details of design and operation will be taken up with appropriate illustrations of the different parts. In view of the fact that the development under consideration is to form a part of a system which is to play a distinct part in Southern industrial development, a brief review of this proposed operating system and the way it will fit into the development movement already under way, will be first taken up.

PROPOSED SYSTEM OF GEORGIA RAILWAY & POWER CO.

Electrical transmission in the South was born in 1895 when a transmission line was constructed from a plant on the Rocky River to Anderson, S. C., a distance of eight miles and used to transmit 175 Hp. of electrical energy at 5,500 volts. The electrical development of the South did not begin in real earnest, however, until the organization of the Southern Power Co., in 1905. This company started with a 10,000 Hp. plant and 47 miles of 13,000 volt transmission lines, and at the present writing it has in the States of North and South Carolina a system furnishing power to 156 mills, 6 street car systems, and carrying the lighting and power loads in 45 towns and villages.

In seventeen years a demand has been created in this section necessitating a plant capacity of about 200,000 Hp. and transmission lines approximating 1,500 miles, with de-

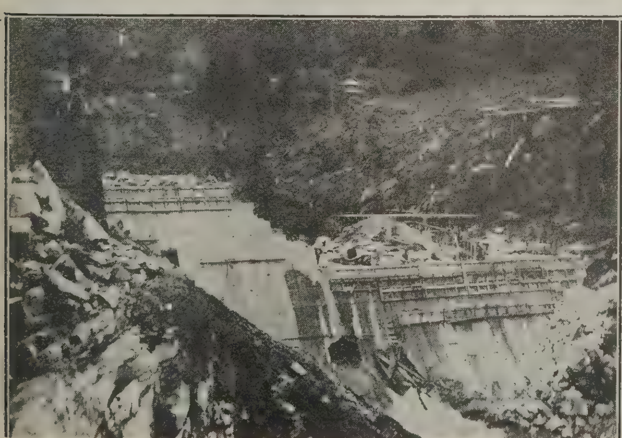


FIG. 1. VIEW OF POWER DAM FROM DOWN STREAM SIDE, WHEN ABOUT HALF COMPLETE.

FIG. 2. VIEW ABOVE POWER DAM SHOWING INTAKE END OF TUNNEL AT RIGHT.

velopments nearing completion of approximately the same amount and a total horsepower of projected plants reaching these two figures put together. The effect of this natural and healthy growth in the demand for electrical energy has spread throughout the South and has been more or less responsible for the conception and organization of the similar large system under consideration to take care of the electrical wants in the State of Georgia and part of Tennessee.

The Georgia Railway & Power Company was organized during the latter part of 1911 and has absorbed hydro-electric development projects in Northern Georgia and taken over by a lease arrangement and operating in connection with its other activities, the electric street railway, electric lighting, heating and power companies formerly controlled by the Georgia Railway & Electric Co., of Atlanta. Among the water power developments consolidated under the Georgia Railway & Power Company are the power plant at Bull Sluice, the Dunlap power plant and the Tallulah power development now in course of completion. This corporation is modeled after the Southern Power Company and has among its immediate plans for the future, the construction of an electric line to Stone Mountain, to connect with the lines formerly operated by the Georgia Railway & Electric Co., at Decatur, and thus establish communication with Marietta, East Point, College Park and other suburbs in Georgia.

As the plans now stand the company proposes to develop electric power, operate street railways and furnish light and power to municipalities and private corporations. It will have as competitors the Southern Power Co., operating in South Carolina close to the Georgia line, the Tennessee Power Co., the Chattanooga and Tennessee River Power Co., the Central Georgia Power Co., and the Columbus Power Company. Through its system of transmission lines, it will furnish power to the cities in Northern Georgia and Eastern Tennessee, including on the east, Elberton,

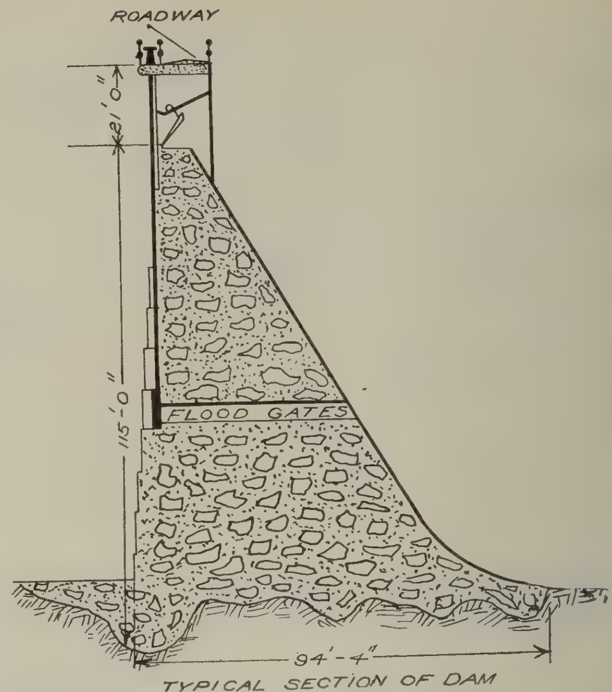


FIG. 4. A TYPICAL SECTION THROUGH THE POWER DAM.

Hartwell, Toccoa, and Clarksville, on the west, LaGrange and Carrolton, on the north, Rome, Dalton, and the marble quarry section about Canton and Jasper, on the south Social Circle and Covington. These points indicate the boundary of the territory planned to serve as shown by the development map herewith, while the intermediate cities and towns will be connected to the transmission system running near them.

In addition to the three water powers already developed and in course of completion, mentioned above, the company owns several other projects which will be developed as the

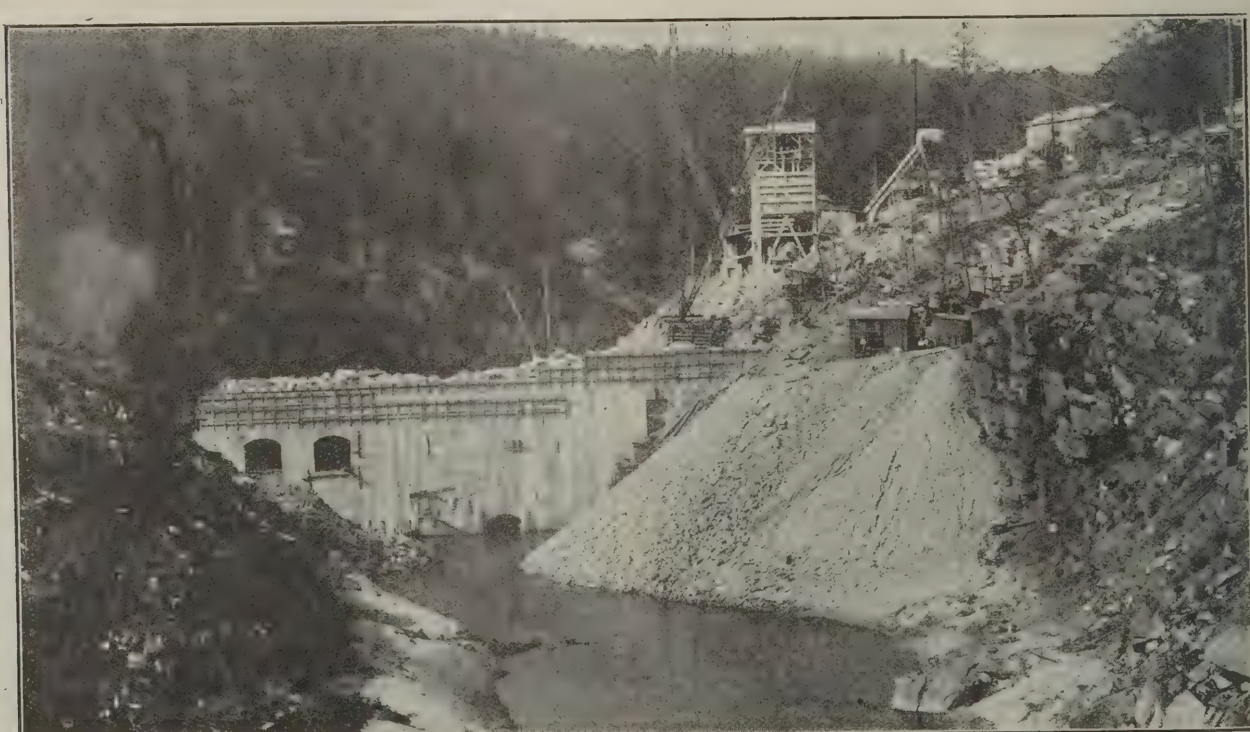


FIG. 3. VIEW OF POWER DAM FROM UP STREAM SIDE, WITH TUNNEL ENTRANCE AT SMALL SHANTY AT RIGHT END OF DAM.

necessity arises. Among these are the water power sites on the Chattahooche River, between the Dunlap plant formerly known as the North Georgia Electric Company's development at Gainesville and West Point, Ga., including the Franklin Shoals property in Heard County, Georgia and sites on the Savannah and Etowah Rivers. The completed system will include ten developments with a total horsepower of 350,000. The developments will be distributed as follows: One on the Etowah, four on the Chattahooche, one at Tallulah, two on the Tugalo, and two on the Savannah. Of these, two on the Chattahooche are completed and in operation, the Bull Sluice and the Gainesville plants, while the development of the Tallulah Falls plant described here is now well under way.

The Dams and General Layout of the Tallulah Plant.

The design of the Tallulah development of the Georgia Railway & Power Co., possess characteristics, the general nature of which are found in very few if any other plants in this country. The work now in the final stages of construction at Tallulah Falls, embraces two dams, a tunnel 6,663 feet long, a surge tank dug in the earth from solid rock, a power house and switch house together with five main substations. The upper of the two dams, known as the Mathis Dam and constructed for storage purposes, is about eight miles up the river from the power dam and will impound approximately four billion cubic feet of water. This dam will be of the Ambursen Cellular type, 650 in length and 90 feet above foundation at the highest point.

The power dam and its relative location in the development lay out is shown in the development map at the beginning of this article. In construction it is of the cyclopean type of masonry, 350 feet long and 115 feet high, furnishing a reservoir capacity of a billion and a quarter cubic feet of water. In Figs. 1, 2, and 3, up and down stream sides of this dam are shown. At the right of Fig. 1 can be seen a portion of the quarry from which the rock is obtained for the construction of the dam.

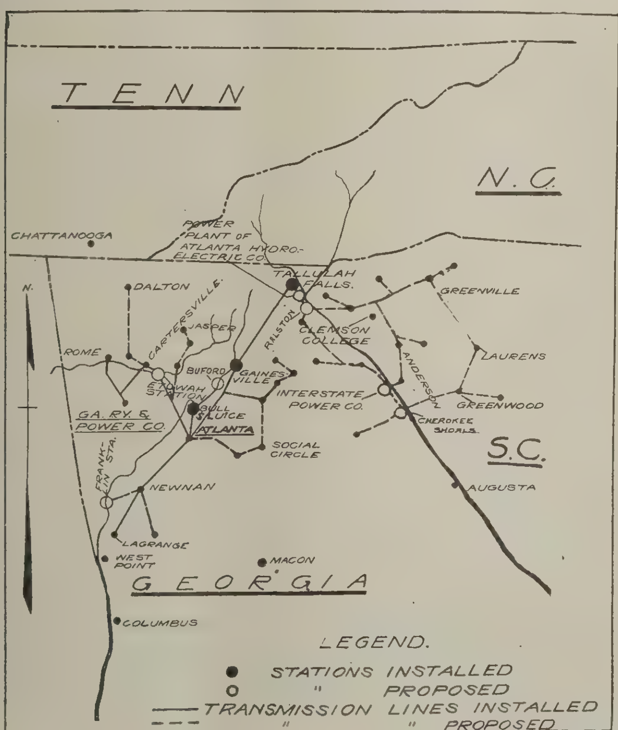


Fig. 5. Map Showing Transmission System.

A typical section of this dam is shown in Fig. 4 above the crest of which will be seen the roadway which will join the river banks when the dam has been completed.

TUNNEL, SURGE TANK AND PENSTOCKS.

An interesting part of the development from an engineering standpoint includes the tunnel leading from the power dam to a surge tank dug from solid rock in the edge and brink of the gorge, 6,663 feet distant. As shown in the development layout map and also at the right of Fig. 2, the intake end of the tunnel starts about 50 yards from the power dam at which point there will be a 31 foot head of water. It follows as direct a route as practicable to the surge tank, the total distance being dug through a practically solid rock strata. The tunnel section is rectangular, 12 feet wide by 14 feet high, with an arch top and has a very slight grade sufficient only to naturally flush out any sediment that may be deposited. It is to be lined with concrete forced into place from a mixer by compressed air. Three adits or outlets for drainage or admittance to the tunnel for other purposes are provided in suitable places where the tunnel comes near the bank of the river gorge in its route.

The surge tank located just above the power house at the brink of the gorge is 30 x 70 feet in horizontal section by 95 feet deep from the surface of the earth. This surge tank really forms a part of the constructed water way from the power dam and will be lined with concrete. The tunnel enters it at the bottom and leading from the opposite side are the six steel penstocks five feet in diameter and 1,100 feet long with a fall from the surge tank end to the turbine wheel of 600 feet. The penstocks are provided with specially designed anchor blocks down the steep incline, a feature which on account of the earth formation, received special engineering attention.

THE POWER HOUSE AND SWITCH HOUSE.

The power house will be constructed with two floors, the super-structure of concrete, the upper part of steel and brick and topped with a tile roof. It will measure 42 x 186 feet. The switch house 46 x 244 feet will be located with its longest dimension parallel with the long dimension of the power house as shown on the development layout map and will have three floors. It is to be constructed with a concrete substructure and a steel and brick superstructure similiar in design to the power house. In this structure will be housed the 19—3,333 K. W. transformers, bus-bars, high and low tension switches, all of General Electric type.

POWER HOUSE EQUIPMENT.

The power house equipment will consist of six General Electric 10,000 K. V. A. Vertical 6,600 volt, 3-phase, 60-cycle, water wheel type generators, each direct connected to a 15,000 H. P., S. Morgan Smith turbine of the Francis type. Direct current excitation for the main units will be furnished by an equal number of 100 K. W. 250 volt exciter sets. Current will be generated at 6,600 volts and stepped up by 18—3,333 K. V. A. transformers to 110,000 volts for transmission over a steel tower system of 196 miles.

TRANSMISSION SYSTEM.

The transmission lines are constructed in duplicate and carried on steel towers throughout, the main circuit being of 4/0 copper and the branch circuits of 2/0 copper and the towers spaced on an average of 8.41 to the mile.

The towers for the transmission lines were designed and

built by the American Bridge Company of New York from specifications furnished by Chas. O. Lenz, Chief Engineer both of the Georgia Railway & Power Co., and the Northern Contracting Co., the general contractor for the work. In all there are 1754 towers, 816 of these being standard for branch circuits and carrying six line conductors of 2/0 copper wire and two 3/8 inch galvanized steel strand ground wires ,the towers being 16 feet square at the base and 70 feet to the upper cross arm. The tower is shown in Figs. 6 and 8.

In view of the fact that the design of these towers received special attention and interesting tests were performed on them, a few of the important details governing their final design is given here. The loads for which they are designed are: (1) A longitudinal pull of 3,000 pounds at right angles to the end of any one cross arm. (2) A vertical load of 1,200 pounds at the ends of any or all cross arms. (3) A load of 1,200 pounds pulling in any direction at the top of the tower. (4) A load of 8,000 pounds pulling at right angles to the line or parallel to the cross arms, that is, 2,000 pounds at each cross arm. At the same time a pull parallel to the line or at right angles to the cross arms of 5,000 pounds, that is, 2,500 pounds in the same or opposite directions at each end of any single cross arm or at one end of any two cross arms.

The cross arms are proportioned for a combined loading of (1), (2), and 1,000 pounds horizontal thrust at end of the arm. The tower is proportioned for maximum combination of (2) and (3) or (2) and (4). Unit stresses used were 25,000 pounds per square inch net for tension and $(25{,}000/[1 + (L^2/18{,}000\ r^2)])$ for compression.

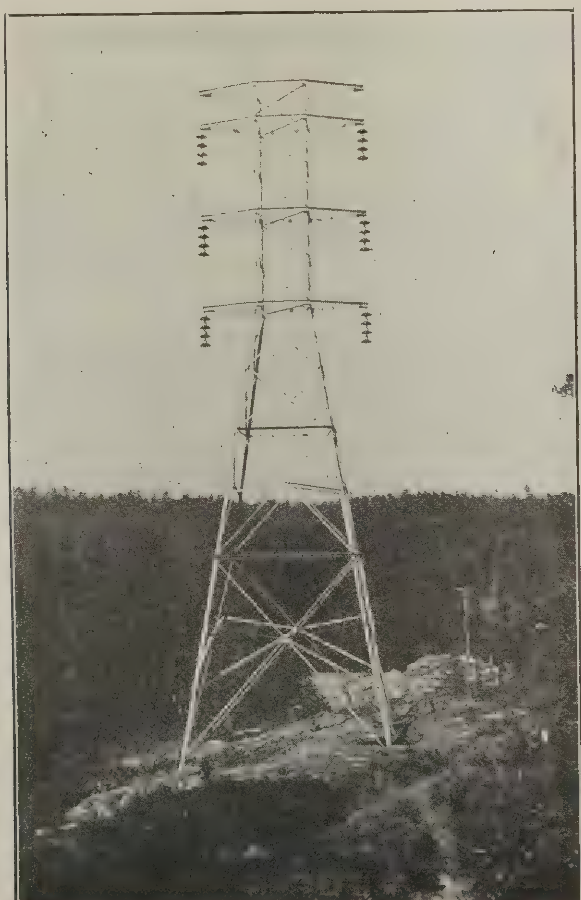


FIG. 6. A STEEL TOWER ERECTED, SHOWING SUSPENSION INSULATORS AND PROVISIONS FOR GROUND WIRES.

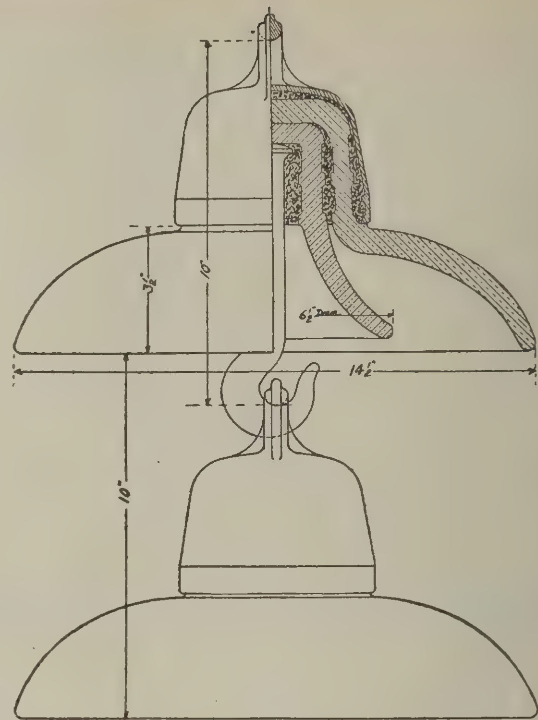


FIG. 7. A SECTION OF SUSPENSION INSULATORS.

The 736 standard towers for main circuits, carrying six line conductors of 4/0 copper wire, and two 7/16 inch galvanized steel strand ground wires, are 20 feet square at the base, 5 feet square at the top, and 66 feet to the upper cross arm. The number and arrangement of members are the same as in the 2/0 tower. The loads for which they are designed are: (1) A longitudinal pull of 4,300 pounds at right angles to the end of any one cross arm. (2) A vertical load of 1,500 pounds at the ends of any or all cross arms. (3) A load of 1,500 pounds pulling in any direction at the top of the tower. (4) A load of 10,000 pounds pulling at right angles to the line or parallel to the cross arms, that is, 2,500 pounds at each cross arm. At the same time a pull parallel to the line or at right angles to the cross arms of 8,000 pounds, that is 4,000 pounds in the same or opposite directions at each end of any single cross arm or at one end of any two cross arms. The combination of loadings and unit stresses are the same as for the towers with 2/0 wires.

In addition to the above standard towers there are 100 special 2/0 towers, 80 feet high carrying in addition to the 2/0 wires, six 4/0 wires; 15 angle towers 66 feet high; 54 angle towers 70 feet high; 23 angle towers 80 feet high, and 10 angle towers 105 feet high. All the towers were fabricated at the Shiffler Plant of the American Bridge Company in Pittsburg. The material was thoroughly galvanized except the bolts, which were sherardized, and all material shipped "knocked down," the assembling at the site and the erection being done by the Northern Contracting Co. The concrete anchorages for all towers had previously been set by the same company.

Tests were made on both the standard 2/0 and the 4/0 towers, the tower being erected complete and tested for vertical, horizontal, and torsional loadings. Referring to the 2/0 towers shown in Fig. 8, the tests made were as follows:

Test 1. A load of 1,200 pounds was placed in turn upon the right hand end of each cross arm. The total deflection

at the top of the tower to the right due to the four loads was ½ inch.

Test 2. An additional load of 1,200 pounds was placed upon the left-hand end of each cross arm. The top of the tower returned to within ⅛ inch of its original position.

Test 3. With the eight vertical loads remaining on the tower a horizontal load of 2,500 pounds was applied at one end of the upper cross arm, pulling at right angles to same. A torsional deflection of ¼ inch was read.

Test 4. Tower was loaded as for Test 3. An additional horizontal load of 2,500 pounds was applied at the other end of the upper cross arm. The result of the 5,000 pound horizontal load was to deflect the tower 1½ inches,

Test 5. With the vertical loads remaining on the tower as for Test 2, a horizontal load was applied at one end of the lower cross arm but caused no deflection.

Test 6. This was the destruction test. With a horizontal pull of 20,000 pounds at the intersection of the upper cross arm and the basket portion of the tower, one of the 4 x 4 x ¼ angle legs of the tower buckled about 12 feet from the ground.

A 4/0 tower was tested some weeks after the test of the 2/0 tower with the following results:

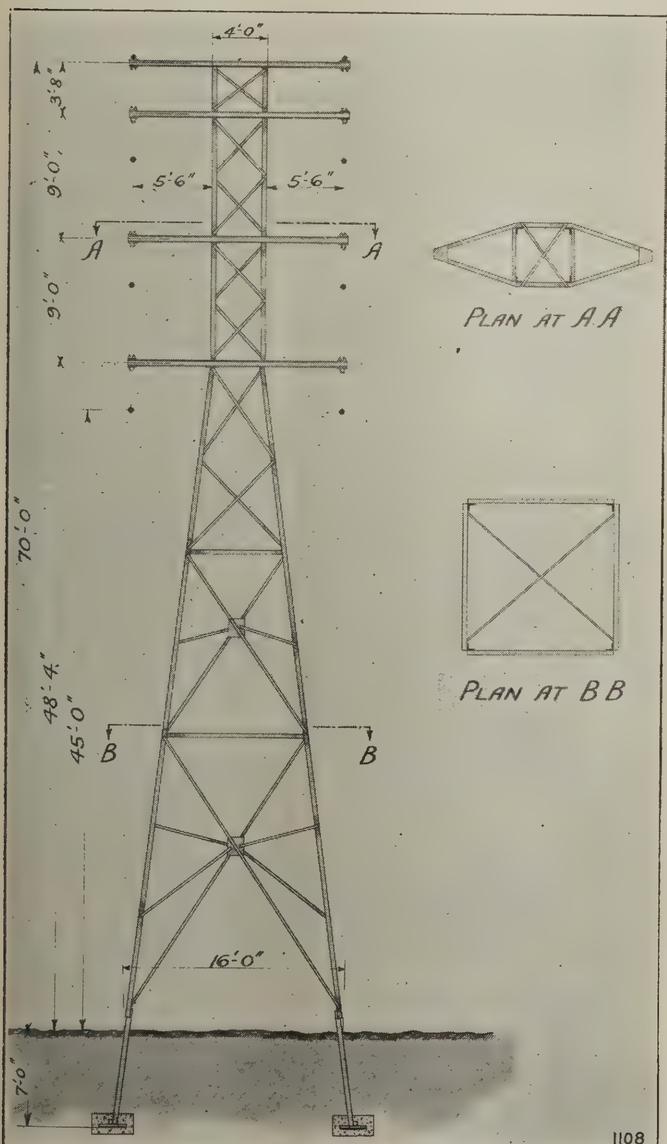


Fig. 8. The Details of a 2/0 Steel Tower.

Test 1. Vertical loads of 1,500 pounds were applied at each end of each cross arm. With the loads on one side the top of the tower deflected ¼ inch. With loads at both ends of each cross arm there was no deflection.

Test 2. All vertical loads remaining, a horizontal load of 2,500 pounds was placed at the end of the upper cross arm pulling in a direction parallel to the cross arm. A deflection of ¾ inch was measured.

Test 3. A horizontal load of 4,300 pounds was applied at one end of the cross arm next to the upper one (3 feet 4 inches from top cross arm of the tower), pulling at right angles to same. The deflection at the top measured ¾ inch. When this load was increased to 8,600 pounds the deflection measured 1⅝ inches. When load was removed the tower returned to within ½ inch of its original position.

Test 4. This was the destruction test. With a horizontal pull of 14,000 pounds at the intersection of the upper cross arm and the basket portion of the tower, a deflection of 4½ inches was noted. This pull was increased to 25,000 pounds when the deflection was 10 inches. With a pull between 25,000 pounds and 27,000 pounds and a deflection of 10⅜ inches the tower failed by one of the 4 x 4 x ¼ angle legs buckling about 40 feet from the ground near the intersection of the inclined portion with the basket portion.

The insulators and clamps for the tower lines were furnished by the R. Thomas & Sons Co., of East Liverpool, Ohio, the type of suspension insulator used being shown in sections in Fig. 7 and shown installed on the tower in Fig. 6. Four of these units shown in Fig. 7 are used for the suspension insulators and five of the same units for the strain insulators. These units were all tested at 150,000 volts and designed for a mechanical strength in tension of not less than 10,000 pounds. The insulators were not crated connected together, but were crated four in one crate ready for assembling at destination after careful inspection.

The general routes of the transmission lines are shown in Fig. 5. Substations will be located at Atlanta, Newnan, Lindale, Gainesville, and Cartersville, in Georgia, and will in most cases contain 1,000 K. V. A. 110,000 volt transformers, together with necessary switchboards, oil switches and circuit breakers. The transformers will in most cases be of the outdoor type. At Atlanta nine 3,333 K. V. A. transformers will be installed, while at the other places named with the exception of Lindale which will have six, all other substations will have three 10,000 K. V. A. 110,000 volt transformers.

The output of the Tallulah Falls plant will be used by cotton mills, other manufacturing plants and small towns, the bulk of the power so far contracted for will however be used at Atlanta where approximately 30,000 K. W. will be used as soon as the equipment is in operation.

Construction Features at Tallulah.

All the equipment used in the construction of the development at Talullah Falls is air operated. A temporary water power plant was installed at a suitable site on the Tallulah River below the power dam where two 2,500 cubic feet compressors are driven by a 1,100 H. P. water turbine and one 200 cubic foot compressor driven by a 100 H. P. turbine. In addition a 2,000 cubic foot compressor is steam driven. Approximately two miles of compressed air and water lines are in operation for drills in tunnels and quarry. An inclined railway from the location of the

surge tank to the power house was permanently constructed before excavation work on the power house began and a 50 ton car is operated on it by a double drum cable hoisting engine.

The total development at Tallulah Falls in its final state will represent an expenditure of about five and a half million dollars. The work has been done by the Northern Contracting Co., for the Georgia Railway & Power Co., Chas. D. Adsit is resident engineer in charge of all construction on the power house, switch house, dam, and tunnel. J. J. Schultheiser is superintendent of line construction in charge of transmission lines and F. H. Sloan is civil engineer in charge of field engineering and building.

The design of the entire development as well as all the engineering details has been under the dirct supervision of Charles O. Lenz, Consulting Engineer of 71 Broadway, New York City.

Instrument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively to* Southern Electrician.)

BY E. P. PECK, ASST. ELECTRICAL ENGINEER, GEORGIA RAILWAY AND POWER CO.

Section 9. Tests on Rotary Converters.

From the operators view point, the characteristics of a rotary converter which should be covered on a test are efficiency, heating, insulation to ground, and commutation on all loads.

EFFICIENCY BY INPUT-OUTPUT METHOD.

The efficiency of small rotaries, 300 K. W. and under, may be measured by the input-output method. The load may be the regular operating load, if it is steady and if it may be varied at will, or some form of rheostat, as described in the section on "Generator Tests," may be used. Tests are made on ½ load, ¾ load, full load and 1½ load.

The rotary should have been in operation for several days previous to the test to wear the bearings, commutator, rings and brushes, to good surfaces. A run with load is made previous to the test to bring the rotary to a constant temperature.

For the test, the load should be adjusted to the desired value and to 100 per cent power factor and readings taken of the input and output of the rotary. A number of readings should be taken on each load and an average of the readings used as the true value. The percent efficiency is obtained thus: Per cent efficiency = 100 X (output ÷ input).

The instrument used on this test should be accurately calibrated as a small error in the measurement of either the input or the output will cause a large error in the efficiency determination. To illustrate assume a 200 K. W. rotary with an efficiency of 93 per cent. The total loss in the rotary is then 14 K. W. An error of ½ per cent in measuring the input is 1 K. W. This is an error of 1 K. W. in 14 K. W. or over 7 per cent of the losses.

The instruments used on the A. C. side for this test should consist of wattmeters, ammeters and voltmeters, with suitable transformers. An ammeter and a voltmeter should be used on the D. C. side. The connections, arrangement of instruments, precautions against instrument errors, etc., are similar to those given in previous articles and will not be taken up here.

EFFICIENCY BY METHOD OF LOSSES.

The efficiency of a large rotary converter is most accurately determined by the method of losses. The losses in a rotary carrying load are: iron loss, windage, bearing friction, A. C. and D. C. brush friction, armature copper (I^2 R) loss, field copper (I^2 R) loss, E I losses in brushes and brush contact, I^2 R losses in leads from terminals to armature and series field, and load losses.

The iron loss, windage and friction is measured while the rotary is running inverted—that is from the D. C. side—and disconnected from its transformers and all other load. The rotary speed is adjusted to normal and a number of readings taken of speed, armature amperes and armature volts. The watts imput (volts X amperes) to the armature is the measure of the above losses.

Included as a part of these losses is a very small copper loss in the armature due to the driving current. This loss is such a small proportion of the other losses that it is usually neglected, but if desired, its value may be calculated from the current and armature resistance, and it may be deducted from the other losses. The losses, measured on this running light test, are practically constant at all loads of the rotary.

If the rotary is started on the A. C. side, then connected on the D. C. side and then disconnected on the A. C. side, it will be necessary to have a man at the field rheostat handle to increase the field current of the rotary as soon as the A. C. side is opened. If this is not done quickly the rotary will run decidedly over speed.

The copper loss in armature, series field and leads, varies with the load and should be calculated for ½ load, ¾ load, full load and 1½ load. These losses are figured from the rated D. C. current of the machine and the resistance of the various sections.

The armature copper loss is (QI^2 Ra), the loss in the series field is (I^2 Rs) and the loss in the leads is (I^2 RL).

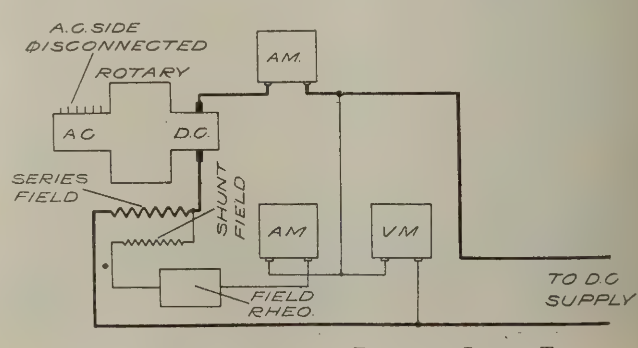


Fig. 1. Connections for Running Light Test.

In the above formula I is the D. C. current delivered by the machine at the specified load, and Ra is the armature resistance measured on the commutator, from the center bar under one brush to the center bar under the next brush, or from rings 1-2, 1-3, 2-3 on a three-phase machine, 1-3, 2-4 on a two-phase machine, and 1-4, 2-5, 3-6, on a six-phase machine.

When the measurements are made, the armature should be turned so that the conductors which are connected by the armature equalizer rings come under the brushes, and readings should be taken under all brushes—the average of the readings being used as the correct result, Rs is the measured resistance of the series field. RL is the sum of the resistances of all connecting leads from the terminal to series field, field to armature, and armature to terminal. The constant Q is used for calculating the armature loss because the entire current from the A. C. rings through the armature to the commutator does not traverse the whole winding, and the copper loss is not the same as in a D. C. machine of the same rating. The constant Q is equal to 147 per cent in single phase, 39 per cent in two phase, 59 per cent in three phase, and 27 per cent in 6-phase rotaries.

The shunt field loss is measured with an ammeter in series with the field and a voltmeter across the D. C. machine terminals. The loss in the field rheosat is included, as it should be, in self excited machines. The shunt field loss is measured with the field current adjusted for unity power factor when the rotary is delivering full load at normal voltage.

All copper loss measurements should be made at operating temperature and the temperature of the room and windings should be taken. Some times it is of advantage to take another set of resistance measurements with the machine cold as a check on the hot resistance test.

The following constants are used to obtain the value of the alternating current in the leads from transformers to rotary, when the direct current is known. Multiply direct current by 1.00 for single-phase; .72 for two-phase; .943 in three-phase; .472 in six-phase, rotaries.

The loss in the A. C. brushes should be neglible. The loss in the D. C. brushes may be measured at each test load with the machine running. For this test to be of any value, the brushes should have been previously fitted to the commutator, worn to a polish in service, and cleaned of grease and gum. The brush tension should be adjusted to the value recommended by the manufacture and the brushes should be set on neutral. The brush loss in watts is W = 2EI in which E is the average voltage measured from D. C. brush ring to the commutator directly under the center of the brushes (care being taken not to get from the positive brush ring to a point under a negative brush or vice versa) and I is the D. C. current of the machine at the test load.

The brush loss is very difficult to measure with accuracy and for this reason several of the large manufacturers recommend that this loss be taken from a table or curve which has been prepared from a large number of carefully made tests.

The following is a table published in the Electrical Journal and used by the Westinghouse Elec. & Mfg. Co., for obtaining the brush drop on carbon brushes, with their explanation of same. "Brush I R Loss—This is found by the use of a formula determined by means of a series of exhaustive experiments. Though for any special form of brush or quality of carbon, it may give results different from the actual, a very good approximation is given when ordinary brushes are used. The formula takes the form of a relation between the current density in the brushes and the volts drop from terminal to terminal of the machine due to the brushes alone. The current density in the brushes for a given armature current is found by dividing the armature current by the area of half the total number of brushes, that is the area of the number of brushes in parallel. This is taken in amperes per square inch. The relation mentioned is: Up to ten amperes per square inch, current density, the drop for every ampere per square inch is .125. In order to find the loss in the brushes due to this drop, it is simply necessary to multiply the drop by the armature current flowing."

"Above ten amperes per square inch, current density, the drop is 1.25 volts plus .025 volt for every ampere per square inch above 10.

DENSITY Amperes Per Square Inch	DROP Volts
5	0.625
10	1.250
15	1.375
20	1.500
25	1.625
30	1.750
35	1.875
40	2.000

The load losses in a rotary consist of eddy current losses due to the load, commutating losses and several other losses. In the modern rotaries these losses are very small and may safely be disregarded.

The percent efficiency equals 100 X output ÷ (output + losses).

HEAT TEST.

The heat test is made at full load and stated overloads by running the machine on its regular load or by a pumping back method, until it has reached a constant temperature as shown by thermometers placed on several of the field coils. When a stationary temperature is reached the machine is stopped and temperature taken on armature conductors, armature iron, and commutator.

The thermometers should be placed on the armature as soon as the machine stops, and should be watched to obtain the maximum temperature. It is a good idea to have the thermometers heated to approximately the temperature expected. Some of the parts may cool before the thermometer has warmed up if this is not done. All thermometers should be held on firmly and should be covered with a small pad of waste or cotton to prevent excessive radiation of heat. Several thermometers should be placed on the field coils and the armature and at least two in the room for air temperature. Ten or twelve thermometers are necessary for this heat test.

PUMPING BACK HEAT TEST.

If another rotary of the same size or a larger size is installed in the same plant, the rotary being tested may drive the other rotary inverted and with proper operation the tested rotary may be brought to full load with the supply line carrying only the losses in the two rotaries. The two machines are started, synchronized and connected to the busses on both A. C. and D. C. sides. The machines may be connected through the equalizer and the switch on the line side of the equalizer opened on both machines as

shown in the diagram of connections Fig. 2. It is here assumed that the equalizer has ample capacity to carry the desired load. If such is not the case temporary connections may be made to cut out the series field on the inverted rotary.

With the machines running as stated the field rheostat of the inverted rotary is turned so that the rotary receives current from the D. C. side. Load is gradually increased by this rheostat to the desired point. The field rheostat on the tested rotary is set so that the power factor of the rotary is 100 per cent. If full load cannot be obtained,

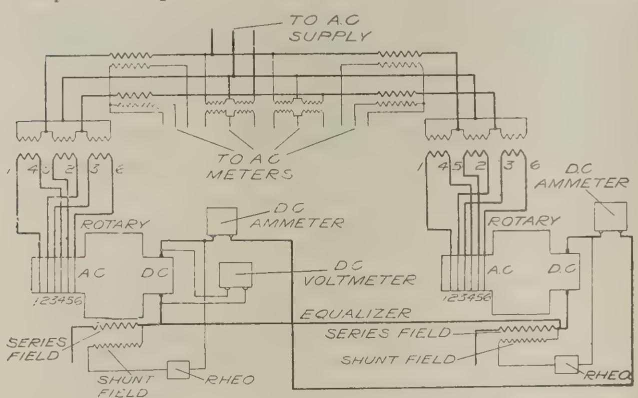


FIG. 2. MACHINE CONNECTIONS FOR HEAT TEST ON ONE ROTARY BY PUMPING BACK METHOD.

the connections to the transformers may be changed to another tap on one rotary and another trial made. It will probably be necessary to shift the brushes on the inverted rotary to prevent sparking.

INSULATION.

An insulation test should be made on the machine. The voltage to be used and methods of making the test have been given in the sections on "Transformer Tests" and "Generator Tests."

COMMUTATION.

The rotary should run without serious sparking at the brushes from no load to 50 per cent overload, without shifting the brushes. Before any tests are made the brushes should be set on the neutral point. It sometimes happens that the brushes are not properly spaced when the machine is assembled, hence the neutral should be determined for each brush. The neutral point is easily located by means of a low reading voltmeter with a scale of 5 or 10 volts full reading. The leads from the voltmeter should be tied to a stick so that the conductors are spaced apart at the end just the width of a commutator bar. These ends are then held on the commutator in line with the center of the brushes. At the neutral point the voltmeter will not read, and the leads and brushes should be shifted if necessary to get this neutral in the center of the brushes.

METER CAPACITY FOR TESTS.

It is often quite difficult to estimate the proper capacity of the meters to be used for measuring the various losses. As a guide in this direction the following average results are given from tests on a number of rotaries of 500 and 1,000 K. W. capacity, 250 and 600 D. C. volts, and speeds of 214, 500 and 600 R. P. M. In order to make the results of more general value meter readings are not given but the figures are the percent of rated full load current which is required on the running light test, and also the field current to be expected, in percent of the full load current.

Amperes required on running light test = 3 to 6 percent of rated full load current. Field amperes = .35 to .6 percent of rated full load current. In the case of a 500 K. W., 600 volt, rotary the full load current is 833 amperes. The current required on the running light test for iron loss, windage, and friction, will probably be between 833 X .03 = 25 amp. and 833 X .06 = 50 amps. The field current will probably be between 833 X .0035 = 2.91 amperes and 833 X .006 = 5 amperes.

The resistance of the various sections of the heavy current conductors are measured by means of an ammeter and milli-voltmeter. For the above sizes of machines a 5 or 10 ampere ammeter will measure the testing current, and a 50 milli-volt voltmeter will measure the drop. The resistance of each section being R = E ÷ I, in which E is the drop in volts and I the test amperes. The station meters may be used for the heat test if they have been previously calibrated.

CORRECTION.—In the section on Transformer Tests, Page 292 of the July issue, last paragraph in the article, it is stated that "The above tests are for a gap of .2 inch between bright needle points." Needles are not used in the General Elctric Co's oil testing apparatus for the gap in the oil. Two small brass discs are used, with a gap of .2 inch between the parallel flat surfaces.

E. P. PECK.

Sixth Annual Convention of the Illuminating Engineering Society.

An announcement of the I. E. S. convention was Published in the August issue of SOUTHERN ELECTRICIAN. The committee on arrangements now states that there is every assurance of most profitable and enjoyable four day which is further confirmed by the program given herewith. The headquarters will be at the Clifton Hotel, Niagara Falls, Ontario, the convention opening on September 16 and continuing in session until the 19th. At appropriate times between sessions, inspections will be made of the Niagara power developments and the many other interesting enterprises peculiar to the location.

The papers to be presented during the convention are as follows: Report of Committee on Progress. A Report of the Committee on Nomenclature and Standards. "Steel Mill Lighting," a report of the committee on illumination of the Association of Iron and Steel Electrical Engineers. "High Pressure Gas Lighting" by Mr. F. W. Goodenough, Chairman of Council, Illuminating Engineering Society, London, Eng. "The Status of High Pressure Gas Lighting" by Mr. George S. Barrows. "Recent Developments in Gas Lighting" by Mr. R. F. Pierce. "Indirect and Semi-Indirect Illumination" by Mr. T. W. Rolph. "Recent Developments in Series Street Lighting" by Dr. C. P. Steinmetz. "Research Methods" by Dr. E. P. Hyde. "The Problem of Heterochromatic Photometry and a Rational Standard of Light" by Dr. H. E. Ives. "Reflection from Colored Surfaces" by Mr. Claude W. Jordan. "Diffuse Reflection" by Dr. P. G. Nutting. "A Study of Natural and Artificial Light Distribution in Interiors" by Mr. M. Luckiesh. "The Physiology of Vision" by Dr. T. A. Woodruff. "The Efficiency of the Eye Under Different Systems of Illumination" by Dr. C. E. Ferree. "A Proposed Method of Determining the Diffusion of Translucent Media" by Mr. E. L. Elliott. "Illumination Charts" by Mr. F. A. Beuford. "The Determination of Illumination Efficiency" by Mr. E. L. Elliott. "An Absolute Reflectometer" by Dr. P. G. Nutting. "Colored Values of Illuminated Surfaces" by Mr. Bassett Jones, Jr.

Alternating Current Engineering

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY WILLIAM R. BOWKER.

Section 13. Control of Variable Speed A. C. Motors.

When an induction motor is employed to drive certain kinds of machinery or apparatus that offer practically constant load, the methods of starting and running as up to the present described fulfil the requirements, but there are practical operative service requirements where the condition of a variable load and speed is often met. This is especially the case with crane motors used for lifting and transporting variable loads, such, for instance, as cranes used in lumber yards, steel plants, iron works, ship yards, and mines.

In many cases, under increasing loads, the motor speed is liable and will fall away from synchronism with the supply circuit and if a certain load limit is exceeded the critical point is reached, and if the motor is not relieved of such excessive loads, will slow down and come to a standstill. This circumstance demands a condition of speed and load control which can be met by utilizing a rheostat control and although a considerable variation of speed is obtained only by the sacrifice of a decreased efficiency and increased cost of manufacture, still at the same time these disadvantages are offset by the practical results attained.

The method most generally employed to attain speed control is by means of a variable resistance, this rheostatic control being inserted in the secondary rotor circuit which obviously is met only by using a coil wound rotor with brushes and slip rings. The speed variation and likewise control of load conditions are obtained by successive steps on the controller, this bringing about an interchange of circuit connections which fulfil the desired object.

The controlling apparatus utilized to perform this function is in principle and practical design similar to a street car controller. An outline diagram is illustrated in Fig. 72, which shows the connections and essential working parts of a three-phase motor and rheostatic controller for variable speeds. The controller has fourteen terminals to the first eight of which are connected leads from the various section terminals of the resistance and are worked R_2 to R_8; these terminals providing the necessary connecting places to obtain rheostatic control in the revolving secondary or rotor circuit. The six lower terminals marked L_1 to L_3, etc., offer the necessary connections for the stationary primary or stator circuit.

Assembled on each of these fourteen terminals are fitted stationary contact fingers or flexible brushes which at various locations or positions of the rotating controller barrel or cylinder, press against contact segments fitted upon the controller spindle. It will be noticed that there are fourteen lines of contact segments which correspond to the fourteen contact fingers or flexible metallic brushes, and that they engage in metallic contact with these brushes as the rotating controller spindle assumes various angular locations of step positions. For instance in this controller there are eight steps or positions of the controller arranged around the arc of a circle and worked 1 to 8, there being corresponding "Forward" and "Reverse" positions. The oblong sections of the diagram represent the metallic contact segments, arranged around and forming arcs of circles which rotate with the controller spindle to which they are rigidly fixed but insulated therefrom, while the heavy solid diagonal and vertical lines connecting the various segments are metallic strips connecting them so as to obtain various electrical circuit combinations. The object of these rotating segments is in practice to perform the function of a circumferentially moving multiple switching device, which in various positions or stops as described in moving along the arc of a circle, comes into metallic contact with one or more of the fingers or stationary flexible brushes, bringing about a combination of circuits and interchange of eletcrical connections.

It will be seen that while the eight upper lines of contact segments are metallically interconnected and also the six lower lines of segments likewise connected, still there is no metallic or electrical circuit connection in any way whatsoever between the eight upper and the six lower contact segments. They are, however, assembled upon the same controller spindle, the eight upper contact segments in combination with the corresponding eight flexible brushes, controlling the electrical combinations of the revolving secondary or rotor circuit, and the six lower controlling the stationary primary stator circuit. In the first notch or stop position of the controller, it will be noticed that it puts the stator in circuit with the supply lines previous to the secondary rotor circuit being connected with the variable resistances, which does not occur until the controller handle is rotated to position or notch number 2. Throughout the various positions 1 to 8 of the controller, various circuit combinations are effected, both in the stator and rotor circuits thus fulfilling necessary essential conditions for a variation of resistance and speed control. In the diagram, R_1 to R_8 represent resistance terminals, L_1, L_2, L_3, supply line terminals, and F_1, F_2 and F_3 stator field terminals.

In Fig. 73 a wiring diagram and development of con-

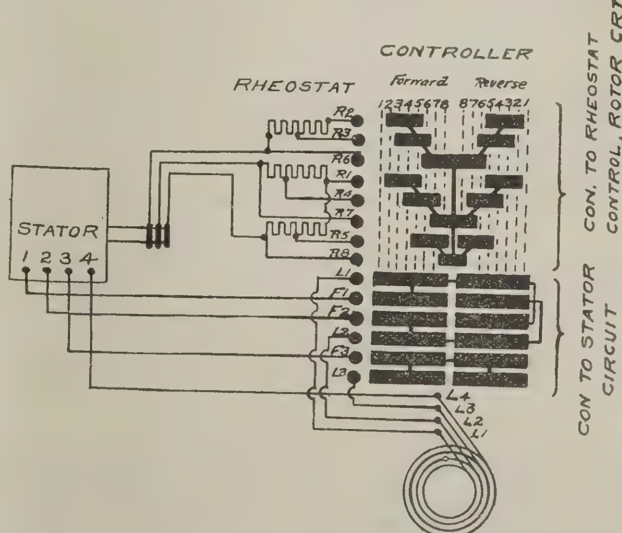


FIG. 72. CONNECTIONS AND ESSENTIAL PARTS OF RHEOSTATIC CONTROLLER FOR VARIABLE SPEEDS OF MOTOR.

troller of a three-phase motor is shown as used where variable speed is desired. In this controller there is a primary cylinder with contact fingers and segments connected to the stationary primary stator circuit, and it will be seen that there is a resistance in the stator circuit as well as one in the secondary rotor circuit. There is also a secondary cylinder with fourteen terminals, fingers and contact segments, the flexible brush terminals or binding posts of which are connected to fourteen sections of the rheostat or ohmic resistance, and the letters of the resistance junctions are connected to similar letters on the finger brush terminals, that is R_1 to R_1, R_2 to R_2, etc.

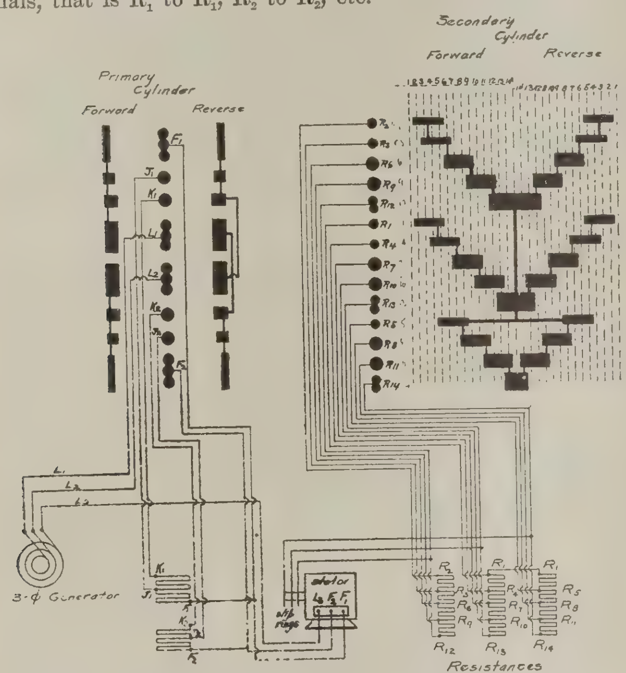


Fig. 73. Wiring Diagram and Development of Controller for Variable Speed.

As in the previous diagram and description there is no metallic or electrical connections between the rotor and stator circuits either external or through the intermediary of the controller. There are fourteen forward and reverse positions of rest or notches on the secondary cylinder of the controller, thus providing for a very gradual, smooth and wide range of speed control. In both Figs. 72 and 73 the "reverse" position is in the primary stator circuit, and the controller interchanges the connections of a pair of leads so as to reverse the direction of rotation of the motor. It will be seen that there is no interchange of connections in the rotor rheostat circuit, it not being necessary, as only the stator terminal connections need be interchanged.

Fig. 74 is a wiring diagram and development of a controller for a three-phase motor and circuit, in which A_1A_2, A_3 are the rotor leads, F_1F_2, F_3 the stator field leads, and B the stator field winding. $L_1L_2L_3$ are the three-phase supply leads. The rheostat or ohmic resistance with terminal connections are represented by the lettering Oa, Ob, Oc, 4a, 4b, 4c, etc.

Referring to the upper half of the diagram, the six upper terminals, E_4 to E_1, have affixed to them the flexible brushes or contact fingers, which press upon the contact segments X, X_1. These segments and brushes control the primary or stator circuit. The fifteen lower terminals and finger brushes as represented by the solid circles A_3 to Ic, are in and control the secondary rotor circuit and each one of the five contact segments Y, is of sufficient depth to bridge over or make contact with three of the brush fingers, for instance, the three fingers on A_3, A_2, A_1 make contact with the upper segment Y in position 6, which is the last notch or full speed position, and it will be noticed that it short circuits the rotor windings A_1, A_2, A_3 in this position, there being no resistance in circuit. The notch positions are markedl to 6 and on notch 2 which is the first or start position for controlling the secondary rotor circuit, all the resistance is in, and as the controller is rotated from 2 to 6

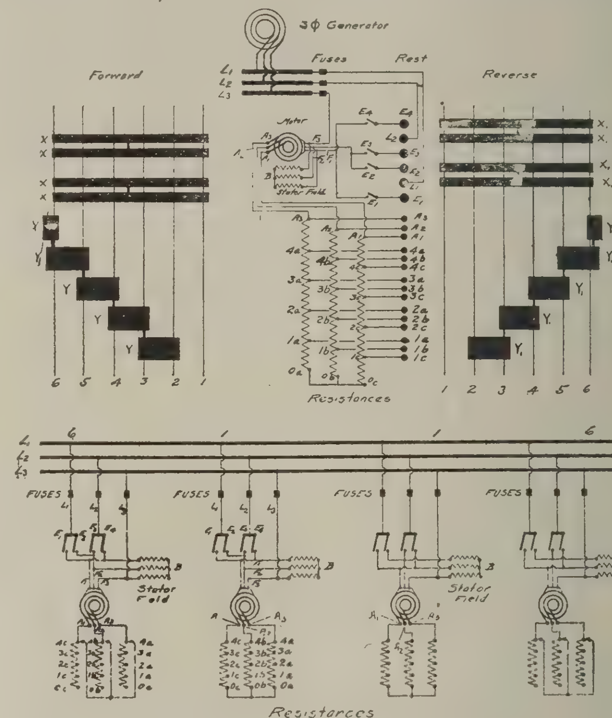


Fig. 74. Wiring Diagram and Development of Controller for 3-Phase Motor and Circuit.

the resistance is gradually cut out of circuit. In position 1 the stator is put in circuit previous to the rotor circuit.

On a careful study of the layout of the upper half of the diagram, it will be seen that the upper contact segment X_1 of the reverse, is not in the same horizontal line with X, it being elevated one finger brush contact higher than the top forward segment. Obviously the controller contacts and segments on the forward control notches do not put the E_4 finger brush into action, while on the reverse movement the bottom segment X_1 does not put the E_1 finger brush into action.

On the reverse movement the contact segments are so assembled and connected that it interchanges or reverses one pair of stator leads. While the upper half of the diagram illustrates the wiring and development of the controller, with controller segments and contacts, the lower half shows the wiring circuit and change of connections that occur in positions 1 and 6, in both the forward and reverse positions, in which it will be seen that in position 1, all the resistance is in circuit, while in position 6 the whole of the resistance is entirely cut out of circuit, as shown by the arrow heads connecting 4a, 4b and 4c, thus practically short circuiting the rotor winding terminals A_1, A_2, A_3.

The ingenuity of the apparatus which so simply and effectively provides for these interchange of circuit connections makes the controller an indispensable auxiliary appliance for such like purposes. A close study of Figs.

72, 73 and 74 is very instructive, more particularly in the layout or design to attain the desired circuit combinations. When two induction motors are utilized in polyphase railway work, to obtain speed variation, the method generally employed is to connect them in tandem or cascade, known as tandem or concatenated control, it being extensively used for both railway and industrial purposes.

The principle involved depends upon the fact that the periodicity or frequency of the current induced in the secondary rotor circuit windings is determined by the "slip." In an induction motor, if no slip exists, which condition only occurs when the rotor is revolving in synchronism with the stator field or current, no current is induced or generated in the rotating secondary or rotor windings. In practical service a slip always results and the current induced in the secondary rotor circuit has a periodicity or frequency determined by the per cent of slip and the frequency of the initial current delivered to the stator. For example, if the frequency of the supply circuit is 50 cycles, and the rotor slip 10 per cent, the frequency of the current induced in the rotor would be 5.

As the speed of the induction motor is determined by the frequency of the supply circuit and delivered to the stator, these rotor currents at decreased periodicity can be delivered through the intermediary of slip ring, brushes and leads to a second induction motor, which motor will start with a considerable torque for the reason that its synchronous speed would only be one-tenth of its original synchronous speed if supplied direct from the line.

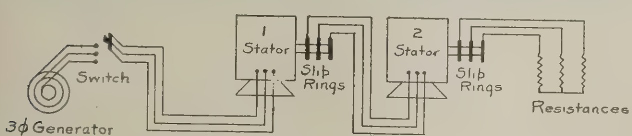


FIG. 75. SHOWING METHOD OF OPERATING TWO MOTORS IN TANDEM OR CASCADE.

A method of operating two motors in tandem is shown in Fig. 75. This affords an excellent practical way of starting two induction motors. The stator of motor No. 1 is supplied with current direct from the three-phase mains, the secondary or rotor being connected to the primary stator circuit of motor No. 2. The stator windings of No. 2 motor being in series with the rotor of motor No. 1, acting as a resistance, obviously starts with a considerable torque and the utilization of the secondary rotor current of No. 1 motor by the primary stator circuit of motor No. 2, increases the efficiency of motor No. 1, for this current is usefully employed and not dissipated in a wasteful rheostat.

The second motor thus receiving its current at a less frequency, starts with considerable torque. In the secondary or rotor circuit is placed a resistance which regulates the rotor current.

It is obvious that the periodicity of the stator field of motor No. 2 is equal to the frequency of the current delivered to it by the rotor of No. 1 motor. By this means the speed is reduced to approximately one half and if the frequency of the initial supply delivered to motor No. 1 is 50 cycles, that of motor No. 2 will be 25 cycles and two motors so connected can be practically considered as being one induction motor having double the number of stator or field poles. A speed lower than half speed can be obtained by increasing the variable resistance in the rotor circuit of No. 2 motor.

In Fig. 75 and description, it explains that the primary stator field of motor No. 2 is connected to the secondary rotor of motor No. 1, but the rotor windings of No. 1 may be, and in practice is, sometimes connected to the rotor windings of motor No. 2, the primary stator windings of motor No. 2 being short circuited.

The two motors connected in tandem control as in Fig. 75 give out a brake horse power approximately equal to that supplied to the stator of motor No. 1, at one-half the normal speed.

The Relation of the Horsepower to the Kilowatt.

There was, before 1911, no precise definition of the horsepower that was generally accepted and authoritative, and different equivalents of this unit in watts are given by various books. The most frequently used equivalent in watts, both in the United States and England, has been the round number, 746 watts; and in 1911 the American Institute of Electrical Engineers adopted this as the exact value of the horsepower. It is obviously desirable that a unit of power should not vary from place to place, and the horsepower thus defined as a fixed number of watts does indeed represent the same rate of work at all places. Inasmuch as the "pound" weight, as a unit of force, varies in value as the acceleration of gravity varies, the number of foot-pounds per second in a horsepower accordingly varies with the latitude and altitude. It is equal to 550 foot-pounds per second at 50° latitude and sea level, approximately the location of London, where the original experiments were made by James Watt to determine the magnitude of the horsepower.

The "continental horsepower," which is used on the continent of Europe, differs from the English and American horse-power by more than 1 per cent, its usual equivalent in watts being 736. This difference is historically due to the confusion existing in weights and measures about a hundred years ago. After the metric system had come into use in Europe, the various values of the horsepower in terms of local feet and pounds were reduced to metric units and were rounded off to 75 kilogram-meters per second, although the original English value was equivalent to 76.041 kilogram-meters per second. Since a unit of power should represent the same rate of work at all places, the "continental horsepower" is best defined as 736 watts, this is equivalent to 75 kilogram-meters per second at latitude 52° 30', or Berlin. The circular gives tables showing the variation with latitude and altitude of the number of foot-pounds per second and of kilogram-meters per second in the two different horsepowers.

These values, 746 and 736 watts, were adopted as early as 1873 by a committee of the British Association for the Advancement of Science. The value, 0.746 kilowatt, will be used in future publications of the Bureau of Standards, as the exact equivalent of the English and American horsepower. It is recognized, however, that modern engineering practice is constantly tending away from the horsepower and toward the kilowatt. The Bureau of Standards of the Department of Commerce and Labor and the Standards Committee of the American Institute of Electrical Engineers recommend the kilowatt for use generally instead of the horsepower as the unit of power.—*Bureau of Standards Bulletin.*

The 1,500 Volt D. C. Railway System of Piedmont and Northern Lines

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN)

BY M. C. TURPIN.

A Description of Equipment Used on the Longest High Voltage Direct Current Electric Road in this Country.

NO better or more convincing example of the rapid growth of the New South in the industrial field and the foremost stand it is taking in electrical matters has ever been furnished than the epoch making advent of the Piedmont and Northern Electrical System in North and South Carolina. When completed, the system, as it is now planned, will comprise 280 miles of track. Two sections have already been completed and are now in operation and it is proposed to later join and extend these two sections. One section is in North Carolina and extends from Charlotte to Kings Mountain, a distance of 35 miles, operated by the Piedmont Traction Company, the other one is in South Carolina, extending from Greenwood through Greenville to Spartanburg, a distance of 95 miles and is operated by the Greenville, Spartanburg and Anderson Railway Company. A 10-mile spur from Belton to Anderson also forms a portion of this section.

The electric energy used as motive power on this system will be direct current at 1,500 volts obtained through synchronous motor generator sets from the alternating current lines of the Southern Power Company. This is unquestionably the most representative high voltage direct-current railroad in the United States as it is the longest direct-current road and the voltage is the highest ever used for direct current service on this continent.

Another interesting feature of this system is that the service will be of four very separate and distinct types as follows: 1. Limited Passenger Service. 2. Local Passenger Service. 3. Light freight and express service. 4. Heavy Freight Service. Each class of service will be handled by a distinct type of motive power. The limited and local passenger service will be handled by motor passenger cars, light freight and express service by what are known as box-car locomotives which in addition to hauling a trailing load of 150 tons are designed for carrying light freight also. The heavy freight is handled in standard freight cars drawn by electric freight locomotives.

FIG. 1. EXTERIOR OF TYPICAL PIEDMONT TRACTION COMPANY'S SUBSTATION.

SUBSTATION EQUIPMENT.

As previously stated, direct current at 1500 volts is obtained from the alternating current lines through motor generator sets. These sets are installed in substations located at various points along the line. The sets consist of the following: A three-phase 60 cycle, 2400-volt, 750 horse-

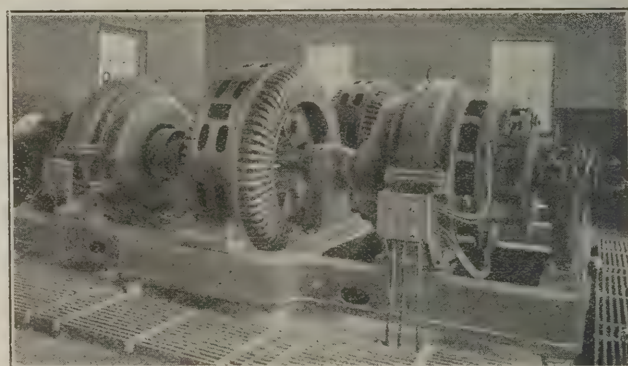


FIG. 2. INTERIOR OF SUBSTATION IN FIG. 1, SHOWING MOTOR GENERATOR SETS.

power synchronous motor direct connected to two 250 kw. direct current generators delivering 750 volts each and connected in series for 1,500 volts. A 6½ Kw. exciter is also mounted on the same shaft.

In so far as possible duplicate equipment is used in all the stations one 500 Kw. direct-current unit being installed in each of the Charlotte, Gastonia, King's Mountain, Dead Falls, Greenville and Gillis sub-stations and two 500 Kw. units have been installed in the Belton, Anderson and Spartanburg sub-stations. On the Greenville, Spartanburg and Anderson system the energy is taken at the Dead Falls station from a 13,200 volt line; and at Belton from a 44,000 volt line which is fed through step-up transformers from a 2200-volt line at the Greenville sub-station. In all of the others, sub-station energy is taken directly from the 2200 volt lines and in every case the voltage on the motors is 2200.

In all of the substations the switchboard equipment is similar as seen in Fig. 4. An interesting feature is that the circuit breakers and knife switches on the 1,500 volt circuits are arranged for remote normal control. Danger of accidents from high voltage flashes in eliminated. In some of the stations a regulator has been installed for maintaining the alternating current voltage approximately constant. It does this by acting on the exciter fields and varying the field excitation of the synchronous motor. Feeders to the trolley circuits are protected with Westinghouse electrolytic lightning arresters.

PASSENGER EQUIPMENT.

The equipment of the limited and local passenger cars is the same and consists of four interpole railway motors,

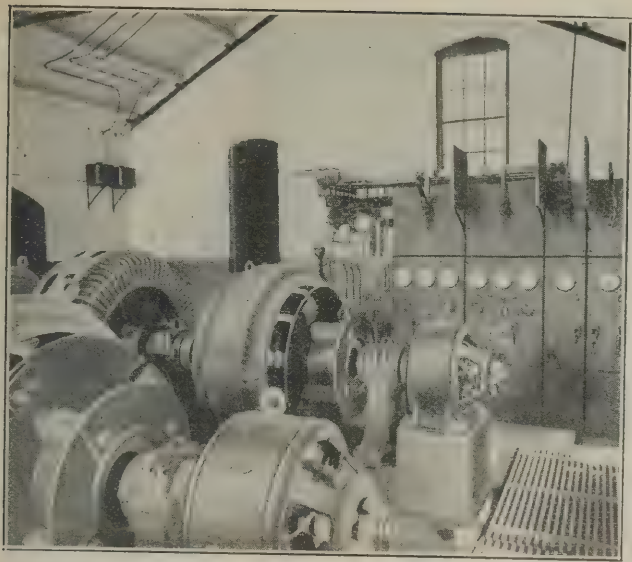


FIG. 3. INTERIOR OF SUBSTATION SHOWING MOTOR GENERATOR SETS AND SWITCHBOARD.

These motors are rated at 110 horsepower at 750 volts and are provided with interpoles to neutralize the magnetic fields that cause sparking. They are the same general construction as standard 750-volt motors but are insulated for 1500 volts.

The passenger cars twenty-three of which are in operation, were built by the Jewett Car Co., Newark, Ohio. In equipment and construction the cars conform to the highest standards of modern construction, the bodies being finished in selected mahogany except for the baggage compartment which is finished in ash and the saloons in white enamel. Leaded glass is used for both the inside and outside gothic sashes. The regular passenger section of each car is divided into compartments for white and colored patrons as shown in Fig. 8.

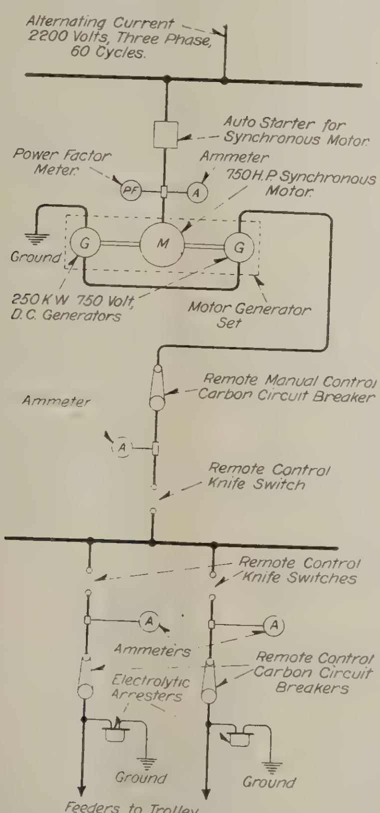


FIG. 5. SCHEMATIC DIAGRAM OF SUBSTATION EQUIPMENT.

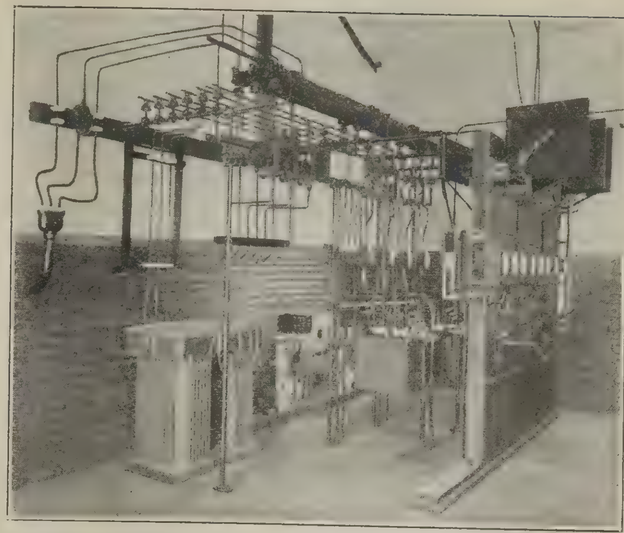


FIG. 4. SWITCHBOARD EQUIPMENT OF PIEDMONT SUBSTATION.

In the front part of the car next to the baggage section is located the negro compartment which has the same class of finished seats and saloon fixtures as the other passenger compartments. To make the negro compartment accessible without passing through the main compartment, and yet have the baggage compartment no longer than necessary for baggage service, the bottom framing of the baggage sliding door, was furnished with triple steps similar to those used on the rear platform. The trap door over these triple steps is arranged to carry the tracks on which the baggage door slides as well as to close the portion of the baggage door opening that remains between step hanger and the door post. This makes the baggage compartment entrance safe for passengers. The cars are equipped for train service and furthermore, while intended for running in one direction only, they can be operated double-end when necessary.

The passenger cars are 60 feet long over all and divided into four compartments as follows. Baggage compartment, 9 feet 8 inches long with folding seats; negro compart-

FIG. 6. HIGH TENSION OIL SWITCHES OF PIEDMONT TRACTION COMPANY'S SUBSTATION.

ment, 7 feet 11⅞ inches long; main compartment, 25 feet 10¾ inches long; smoking compartment, 11 feet 3¼ inches long; vestibule, 4 feet 3 inches long. The width of the cars over the side posts is 9 feet 1 inch. Separate toilet facilities are provided in the negro and main passenger compartments.

For handling light freight and express, cars similiar to baggage cars have been purchased. One of these is shown in the illustration in Fig. 9. In addition to carrying a load of express or light freight these cars are capable of hauling a trailing load of 150 tons. They were built by the Southern Car Company of High Point, North Carolina and are equipped with Westinghouse motors, the same as used on the passenger cars, and H. L. control. Although plainly finished the cars are very neat in appearance and vestibules and control stations are provided at each end, so the car can operate in either direction.

For heavy freight service there are six 55-ton locomotives each equipped with four interpole railway motors rated at 185 horse power each at 750 volts. The continuous rating of each motor with forced ventilation is 135 horse power. The locomotives are of the steeple type with a

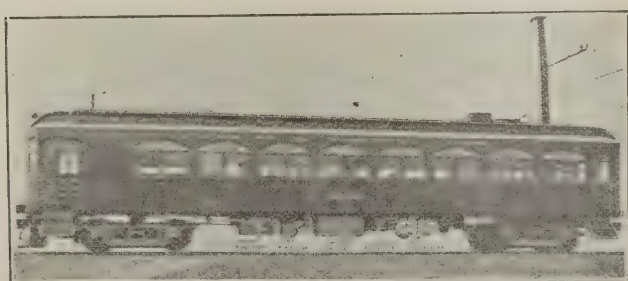


Fig. 7. A 1,500 Direct Current Motor Passenger Car.

slanting hood at each end, weigh 55 tons each, and are arranged for double-end operation. Forced ventilation is provided by centrifugal blowers that supply air to two central conduits each connected with two of the motors. The blowers are driven by a 13 Kw. dynamotor located in the hood of the locomotive which also performs the other functions described including the driving of the air compressor.

The locomotive is capable of exerting a tractive effort of 13,700 pounds at approximately 20 miles per hour for one hour and a momentary tractive effort on clean dry rails of approximately 27,000 pounds. It will haul an 800-

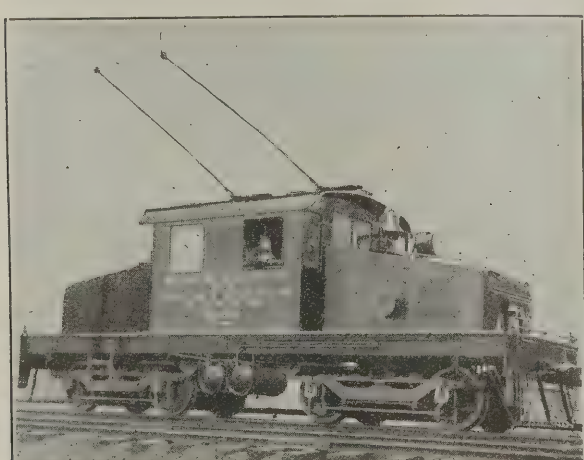


Fig. 10. A Direct Current Locomotive on Piedmont Traction Company's System.

Fig. 9. An Express Car Locomotive for Handling Light Freight and Express.

ton train on a straight level track at a speed of 25 miles per hour with a delivered voltage on the trolley of 1,500.

The Control System is the same on all types of motive power, namely, what is known as the Westinghouse type HL pneumatically operated unit switch type which appears to be particularly well adapted for use on high voltages. The essential features adapting it for this work seem to be the holding of the contacts together under great pressure

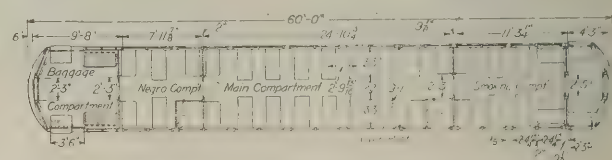


Fig. 8. Plan View of Car in Fig. 7.

and their operating by powerful springs, thus assuring positive action. An exceptionally effective blow-out of the magnetic type is provided for extinguishing the arc due to opening the circuit. The duty imposed on a 1500-volt control equipment is unusually severe but the construction of the switches is such that the use of liberal insulation and creepage-distance is possible. Low voltage (100-125) is

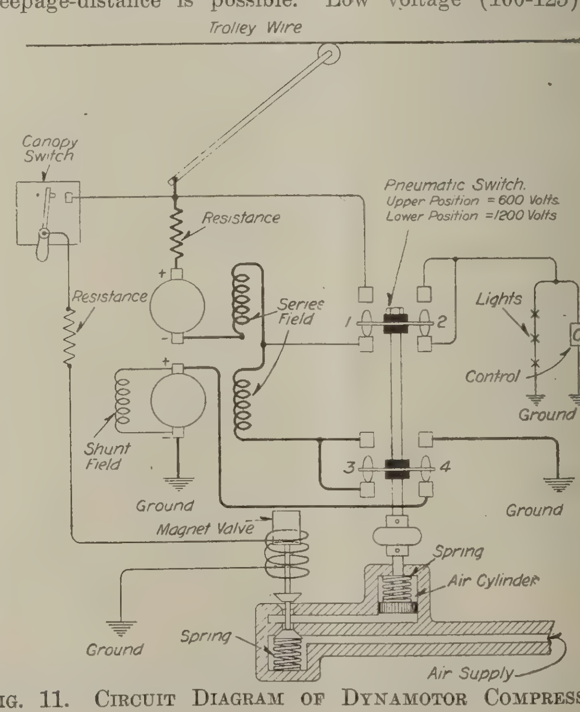


Fig. 11. Circuit Diagram of Dynamotor Compressor.

used on the auxiliaries, and is supplied from a dynamotor described below, through a resistance.

The control equipment is designed for use in connection with the air-brake outfit in which an air compressor is driven by a continuously running dynamotor instead of the usual intermittently running compressor motor. The dynamotor compressor is used on railway cars and locomotives for furnishing low voltage current for operating the lighting and control circuits and at the same time running the compressor. It has two separate armature windings on the same core each connected to a commutator. These two windings are connected in series and each has a series field winding so that one-half the line voltage (1500) is impressed on each winding. A shunt field winding is connected across the heads of armature on the ground side of the circuit so as to maintain an approximately constant speed. The dynamo-compressor therefore is connected between trolley and ground and operates continuously and performs the combined function of furnishing current at half voltage (750 volts) for the control and lighting circuits and driving the compressor, thus combining two machines into one. The sketch in Fig. 11 shows the connections. The governor of the air brake system operates a clutch between the compressor and the dynamotor, and this engages the former when the air pressure reaches the lower limit of the governor, and disengages it when the upper limit is reached.

The entire electrical equipment for motor cars, locomotives and substations was furnished by the Westinghouse Electric and Mfg. Co., East Pittsburg, Pa.

A Study of Polyphase Relations by Kirchoff's Laws

(*Contributed Exclusively to* Southern Electrician)

BY B. C. DENNISON, ASST. PROFESSOR ELECTRICAL ENGINEERING, CARNEGIE TECHNICAL SCHOOLS, PITTSBURG, PA.

The Solution of Various Problems, Giving Vector Relations. Continued from June Issue.

Methods of measuring power in polyphase circuits are generally known and universally applied. Not everyone using these methods, however, is able to justify their use or to tell in what cases some other method might be applicable. It is the purpose of the author to establish simple equations which shall show the limitations of various methods in common use. The following cases will be considered: A. Three-wire systems, symmetrical and unsymmetrical. B. Four-wire systems, symmetrical and unsymmetrical.

A. Three-wire systems.

Under this head are usually met the two-phase three-wire and three-phase, three-wire systems. As a limiting case the three-wire, single-phase system should be included. The following methods of power measurement will be considered: 1. The three-wattmeter method. 2. The two-wattmeter method. 3. The one-wattmeter method.

1. *The Three-Wattmeter Method.* Since in this method a wattmeter is placed in each branch of the load, each wattmeter will measure the true power in its branch and the sum of the readings will be the total power of the system. The connections are shown in Fig. 1. This method applies to any three-wire system in which there are three branches of the load. Thus, referring to Figs. 1 and 2, the power in the branch ab, of the load is,

$$W_1 = IabEab \cos \Theta_1 \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Wattmeter W_1 measures this power for the branch in question. The two remaining wattmeters measure the corresponding values for the other branches so that the sum of the wattmeter readings is the total power of the system.

Equation (1) indicates that the power in a given circuit equals the "product of the applied pressure multiplied by the component of the current in phase with the pressure." This is illustrated in Fig. 2. It may also be considered as the "product of the current multiplied by the component of the pressure in phase with the current." This is illustrated in Fig. 3. In the semigraphical proofs which follow for various systems and methods of measurement, this proposition is constantly made use of.

A second proposition used in conjunction with the above, is that, "the projection of a vector upon a given reference line equals the sum of the projections upon that reference line of the several component vectors, which united form the given vector. This is illustrated in Fig. 4. As is there shown,

$$Eab \cos \Theta = Eao \cos a + Eob \cos B$$

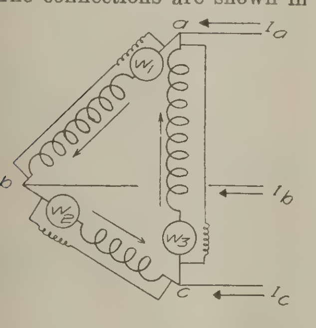


FIG 1

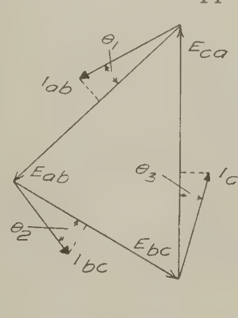


FIG 2

Fig. 1. Three Wattmeter Method of Measuring Power in 3-Wire Mesh System. Fig. 2. Vector Relations for Conditions in Fig. 1.

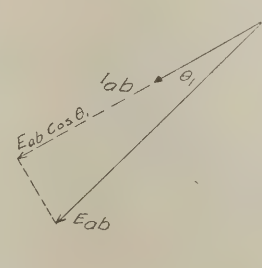


FIG. 3

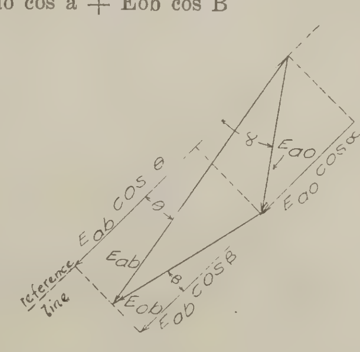


FIG 4

Fig. 3. Projection of Pressure Upon Current Vector. Fig. 4. Projection of a Vector and Its Components Upon a Common Reference.

where Eab = Eao + Eob.

2. *The Two-Wattmeter Method.* In this system of measuring power in three-wire systems, the meters are connected as in Fig. 5. The wattmeter readings are:

$$\left.\begin{array}{l} W_1 = IaEab \cos \Phi_1 \\ W_2 = IcEcb \cos \Phi_2 \end{array}\right\} \ldots\ldots\ldots\ldots (2)$$

But, as is seen by a consideration of Figs. 6 and 7,

$$\left.\begin{array}{l} Ia \cos \Phi_1 = Iab \cos \Theta_1 - Ica \cos (Y + \Theta_3) \\ Ic \cos \Phi_2 = - Ibc \cos \Theta_2 + Ica \cos (B - \Theta_3) \end{array}\right\} \ldots (3)$$

Since $Ia \cos \Phi_1$ = projection of Ia upon the pressure Eab,
$Ic \cos \Phi_2$ = projection of Ic upon the pressure Ecb.
Θ_1 = phase angle between Iab and Eab,
$(Y + \Theta_3)$ = phase angle between Ica and Eab,
Θ_2 = phase angle between Ibc and Ebc,
$(B - \Theta_3)$ = phase angle between Ica and Ebc.

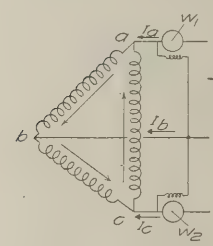
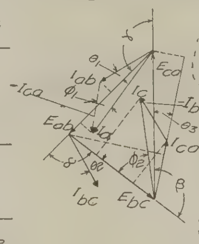
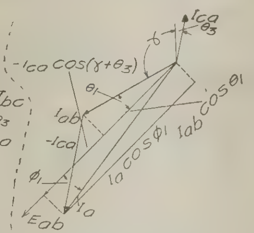




FIG. 5 FIG. 6 FIG. 7

FIG. 5. TWO-WATTMETER METHOD IN A THREE-WIRE SYSTEM. FIG. 6. VECTOR RELATIONS IN TWO-WATTMETER METHOD, 3-WIRE MESH-CONNECTED SYSTEM. FIG. 7. PROJECTIONS OF IA AND ITS COMPONENT VECTORS UPON EAB.

From equations (2) and (3) the sum of the wattmeter readings is

$$W_1 + W_2 = IabEab \cos \Theta_1 - IbcEcb \cos \Theta_2 - Ica \left[Eab \cos (Y + \Theta_3) - Ecb \cos (B - \Theta_3)\right] \ldots (4)$$

But, as may be seen by referring to Fig. 6,

$$Eab \cos (Y + \Theta_3) - Ecb \cos (B - \Theta_3) = - Eca \cos \Theta_3 \ldots\ldots\ldots (5)$$

From equations (4) and (5), writing Ebc for — Ecb,

$$W_1 + W_2 = IabEab \cos \Theta_1 + IbcEbc \cos \Theta_2 + IcaEca \cos \Theta_3 \ldots\ldots\ldots (6)$$

This is the total power in the system, so that the two wattmeters give a correct indication of the total power. As the values chosen are perfectly general, the method is seen to be correct for all three-wire systems, whether three-phase or two-phase, symmetrical or unsymmetrical, balanced or unbalanced with non-inductive or inductive loads.

The above proof made use of the relations in the delta or mesh system of connections. For the star-connected system the relations are as follows, referring to Figs. 8 and 9.

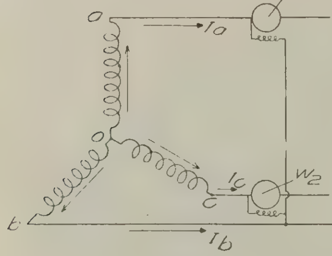
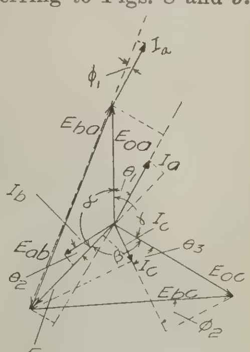



FIG 8 FIG 9

FIG. 8. TWO-WATTMETER METHOD IN STAR-CONNECTED, 3-WIRE SYSTEM. FIG. 9. VECTOR RELATIONS IN THE STAR-CONNECTED SYSTEM.

$$\left.\begin{array}{l} W_1 = IaEba \cos \Phi_1 \\ W_2 = IcEbc \cos \Phi_2 \end{array}\right\} \ldots\ldots\ldots\ldots (6)$$

But (see Fig. 9)

$$\left.\begin{array}{l} Eba \cos \Phi_1 = Eoa \cos \Theta_1 - Eob \cos (a + \Theta_1) \\ Ebc \cos \Phi_2 = Eoc \cos \Theta_3 - Eob \cos (B - \Theta_3) \end{array}\right\} \ldots (7)$$

Therefore,

$$W_1 + W_2 = IaEoa \cos \Theta_1 + IcEoc \cos \Theta_3 - Eob \left[Ia \cos (a + \Theta_1) + Ic \cos (B - \Theta_3)\right] \ldots\ldots (8)$$

But, (see Fig. 9)

$$Ia \cos (a + \Theta_1) + Ic \cos (B - \Theta_3) = - Ib \cos \Theta_2 \ldots (9)$$

since the vector sum of the three currents is zero.

Therefore

$$W_1 + W_2 = IaEoa \cos \Theta_1 + IbEob \cos \Theta_2 + IcEoc \cos \Theta_3$$

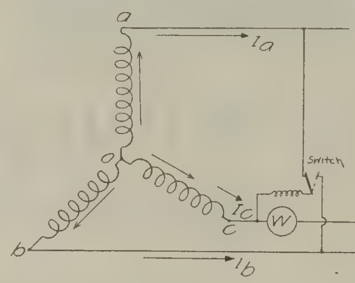
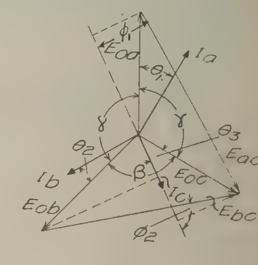



FIG. 10. FIG. 11

FIG. 10. SINGLE-WATTMETER METHOD. FIG. 11. VECTOR RELATIONS IN SINGLE-WATTMETER METHOD.

which is the total power of the system under all conditions. The method is therefore equally applicable to star or mesh-connected systems.

3. *The Single-Wattmeter Method.* In the single-wattmeter method, which is sometimes applicable to three-wire systems, the connections are as in Fig. 10, i. e., the wattmeter is connected with its current coil in one of the three lines and its potential coil connected alternately between that line and each of the other lines in turn.

The wattmeter readings are, see Figs. 10 and 11,

$$\left.\begin{array}{l} W_1 = IcEac \cos \Phi_1 \\ \text{and } W_2 = IcEbc \cos \Phi_2 \end{array}\right\} \ldots\ldots\ldots\ldots (10)$$

As may be seen from Fig. 11,

$$\left.\begin{array}{l} Eac \cos \Phi_1 = Eoc \cos \Theta_3 - Eoa \cos (Y + \Theta_3) \\ Ebc \cos \Phi_2 = Eoc \cos \Theta_3 - Eob \cos (B - \Theta_3) \end{array}\right\} \ldots (11)$$

Therefore,

$$W_1 + W_2 = 2Ic \cdot Eoc \cos \Theta_3 - IcEoa \cos (Y + \Theta_3) - IcEob \cos (B - \Theta_3) \ldots\ldots\ldots (12)$$

For three-phase systems, balanced load,

$$Eoa = Eob = Eoc,$$
$$Y = B = 120°,$$

so that

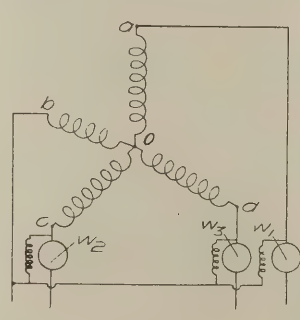
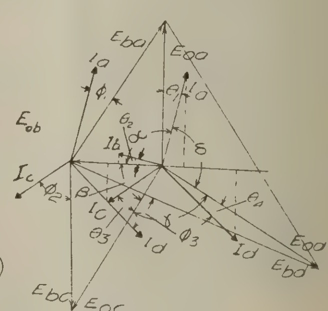



FIG 12 FIG 13

FIG. 12. CONNECTIONS FOR MEASURING POWER IN A 4-WIRE SYSTEM. FIG. 13. VECTOR RELATIONS IN AN UNSYMMETRICAL 4-WIRE SYSTEM.

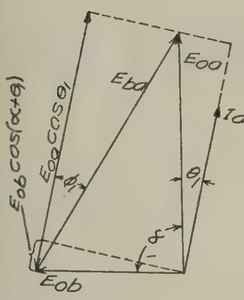


FIG. 14.

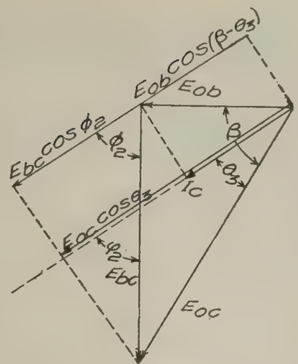


FIG. 15.

FIG. 14. PROJECTIONS OF EBA AND ITS COMPONENT VECTORS UPON IA. FIG. 15. PROJECTIONS OF EBC AND ITS COMPONENT VECTORS UPON IC.

$$\text{Eoa} \cos (Y + \Theta_3) = \text{Eoc} (\cos 120° \cos \Theta_3 - \sin 120° \sin \Theta_3)$$

$$\text{Eob} \cos (B - \Theta_3) = \text{Eoc} (\cos 120° \cos \Theta_3 + \sin 120° \sin \Theta_3).$$

Substituting these values in the equation for $W_1 + W_2$ and evaluating, $W_1 + W_2 = 3\ \text{IcEoc} \cos \Theta_3 =$ total power. Therefore, for balanced three-phase systems, inductive or non-inductive the single-wattmeter method gives correct results.

Applying equation (12) to a two-phase, three-wire system, at balanced load,

$$\text{Eoc} = 0,\ \text{Eoa} = \text{Eob} = E$$
$$B = Y = 135°$$
$$\text{Ic} = \sqrt{2}\ \text{Ia} = \sqrt{1}\ \text{Ib} = \sqrt{2}\ I$$

Equation (12) becomes,

$$\begin{aligned} W_1 + W_2 &= 0 - \sqrt{2}\ I\ E \cos (135° + \Theta) - \sqrt{2}\ I\ E \cos (135° - \Theta) \\ &= -\sqrt{2}\ I\ E (\cos 135° \cos \Theta - \sin 135° \sin \Theta) \\ &\quad - \sqrt{2}\ I\ E (\cos 135° \cos \Theta + \sin 135° \sin \Theta) \\ &= 2\ I\ E \cos \Theta \end{aligned}$$

which is the total power in the balanced two-phase system. The single wattmeter method is therefore applicable to the balanced two-phase, three-wire system.

B. FOUR-WIRE SYSTEMS.

1. *Four-Wattmeter Method.* With four wattmeters connected, one in each branch of the load or supply, the total power is the sum of the four wattmeter readings, or,

$$W_1 + W_2 + W_3 + W_4 = \text{IaEoa} \cos \Theta_1 + \text{IbEob} \cos \Theta_2 + \text{IcEoc} \cos \Theta_3 + \text{IdEod} \cos \Theta_4 \qquad (13)$$

Therefore, any method which correctly gives the total power must satisfy this equation.

2. *Three-Wattmeter Method.* With three wattmeters connected as in Fig. 12, the sum of the three meter readings is,

$$W_1 + W_2 + W_3 = \text{IaEba} \cos \Phi_1 + \text{IcEbc} \cos \Phi_2 + \text{IdEbd} \cos \Phi_3 \qquad (14)$$

From Figs. 14, 15 and 16, it may be seen that,

$$\left.\begin{aligned} \text{Eba} \cos \Phi_1 &= \text{Eoa} \cos \Theta_1 - \text{Eob} \cos (a + \Theta_1) \\ \text{Ebc} \cos \Phi_2 &= \text{Eoc} \cos \Theta_3 - \text{Eob} \cos (B - \Theta_3) \\ \text{Ebd} \cos \Phi_3 &= \text{Eod} \cos \Theta_4 - \text{Eob} \cos (B + Y - \Theta_4) \end{aligned}\right\} \qquad (15)$$

From equations (14) and (15)

$$\begin{aligned} W_1 + W_2 + W_3 = {} & \text{IaEoa} \cos \Theta_1 + \text{IcEoc} \cos \Theta_3 \\ & - \text{Id Eod} \cos \Theta_4 \\ & + \text{Eob} [- \text{Ia} \cos (a + \Theta_1) \\ & - \text{Ic} \cos (B - \Theta_3) \\ & - \text{Id} \cos (B + Y - \Theta_4)] \qquad (16) \end{aligned}$$

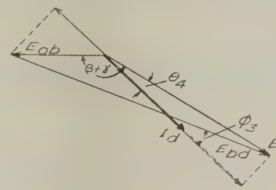


FIG. 16

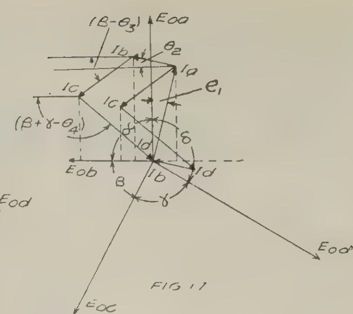


FIG. 17

FIG. 16. PROJECTIONS OF EBD AND ITS COMPONENT VECTORS UPON ID. FIG. 17. PROJECTIONS OF CURRENTS UPON EOB, THE CURRENT VECTORS FORMING A CLOSED POLYGON.

But, from Fig. 17

$$- \text{Ia} \cos (a + \Theta_1) - \text{Ic} \cos (B - \Theta_3) - \text{Id} \cos (B + Y - \Theta_4) = \text{Ib} \cos \Theta_2$$

Therefore equation (16) becomes,

$$W_1 + W_2 + W_3 = \text{IaEoa} \cos \Theta_1 + \text{IbEob} \cos \Theta_2 + \text{IcEoc} \cos \Theta_3 + \text{IdEod} \cos \Theta_4,$$ which is the total power of the system.

This shows that three wattmeters show the correct power, for all conditions of the circuit. While the proof has been applied to the star-connected system it applies equally to the mesh-connected system as might be proven in a similar manner, or as is evident from the fact that with given line currents and pressures the power is independent of the manner of connection of the load or supply.

3. *Two-Wattmeter Connection.* With two wattmeters connected as in Fig. 18, the readings are (see Fig. 19),

$$\left.\begin{aligned} W_1 &= \text{IaEca} \cos \Phi_1 \\ W_2 &= \text{IdEbd} \cos \Phi_2 \end{aligned}\right\} \qquad (17)$$

From Fig. 19,

$$\left.\begin{aligned} \text{Eca} \cos \Phi_1 &= \text{Eoa} \cos \Theta_1 - \text{Eoc} \cos (a + B + \Theta_1) \\ \text{Ebd} \cos \Phi_2 &= \text{Eod} \cos \Theta_4 - \text{Eob} \cos (B + Y - \Theta_4) \end{aligned}\right\} \qquad (18)$$

Therefore,

$$W_1 + W_2 = \text{IaEoa} \cos \Theta_1 - \text{IaEoc} \cos (a + B + \Theta_1) + \text{IdEod} \cos \Theta_4 - \text{IdEob} \cos (B + Y - \Theta_4) \qquad (19)$$

If the following conditions are met this will be the total power, i. e., if,

$$\text{Ib} = \text{Id and Ia} = \text{Ic}$$
$$\Theta_1 = \Theta_3 \text{ and } \Theta_2 = \Theta_4$$
$$a + B = 180° \text{ and } B + Y = 180°$$

then

$$\begin{aligned} W_1 + W_2 &= \text{IaEoa} \cos \Theta_1 - \text{IcEoc} (180° + \Theta_3) + \text{IdEod} \cos \Theta_4 - \text{IbEob} \cos (180° - O_2) \\ &= \text{IaEoa} \cos \Theta_1 + \text{IcEoc} \cos \Theta_3 + \text{IdEod} \cos \Theta_4 + \text{IbEob} \cos \Theta_2 \end{aligned}$$

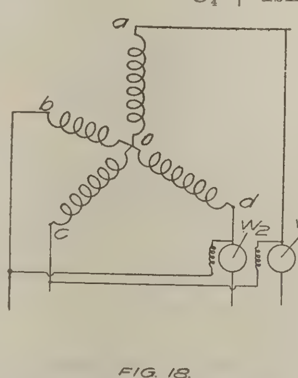


FIG. 18.

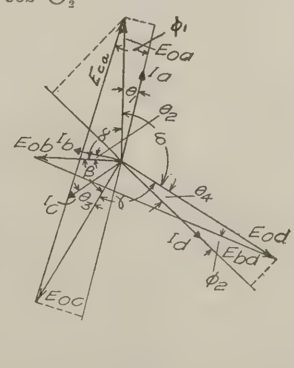


FIG. 19.

FIG. 18. TWO-WATTMETER METHOD IN 4-WIRE SYSTEM. FIG. 19. VECTOR RELATIONS WITH TWO WATTMETERS.

which is the total power. The above conditions are met by a two-phase four-wire system in which the phases are independent.

Also, if,

$$a = B = Y = d = 90°$$
$$Eoa = Eob = Eoc = Eod = E$$
$$Ia = Ib = Ic = Id = I$$

Then $W_1 + W_2 = 4\ EI \cos \Theta =$ total power in a symmetrical quarter-phase system with balanced load.

4. *Two-Wattmeter Method Using Three Current Transformers.* It is frequently necessary to measure power in a four-wire system such as the three-phase system with neutral return, and to do this with a two-movement polyphase wattmeter or with two single-phase wattmeters. To do this it is necessary to use three current transformers. The connections are shown in Fig. 20. For simplicity assume the current transformers to have a ratio of unity. The cur-

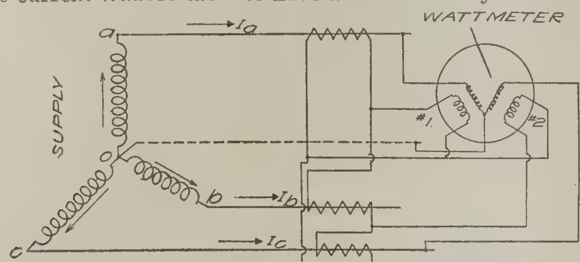


FIG. 20. CONNECTIONS FOR POWER IN A 4-WIRE, 3-PHASE SYSTEM USING TWO WATTMETERS.

rent transformers are connected in delta as shown more simply in Fig. 21. The current in wattmeters No. 1 and No. 2 are (see Fig. 22),

$$\left.\begin{aligned} I_1 &= Ia - Ib \\ -I_2 &= -Ib + Ic \end{aligned}\right\} \dots\dots\dots\dots\dots\dots (20)$$

Referrin gto Fib. 22 the two wattmeter readings are,

$$\left.\begin{aligned} W_1 &= I_1 Eoa \cos \Phi_1 \\ W_2 &= -I_2 Eoc \cos \Phi_2 \end{aligned}\right\} \dots\dots\dots\dots (21)$$

But,

$$\left.\begin{aligned} I_1 \cos \Phi_1 &= Ia \cos \Theta_1 - Ib \cos (a - \Theta_2) \\ -I_2 \cos \Phi_2 &= Ic \cos \Theta_3 - Ib \cos (B + \Theta_2) \end{aligned}\right\} \dots\dots (22)$$

Note that $-I_2 \cos \Phi_2$ is used in order that the wattmeter reading may be positive.

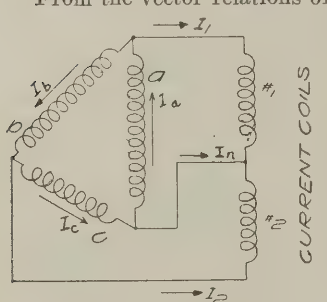
From equations (22) and (21),

$$\left.\begin{aligned} W_1 &= EoaIa \cos \Theta_1 - EoaIb \cos (a - \Theta_2) \\ W_2 &= EocIc \cos \Theta_3 - EocIb \cos (B + \Theta_2) \end{aligned}\right\} \dots\dots (23)$$

The sum of the two readings, or the total reading of the polyphase wattmeter is

$$W_1 + W_2 = EoaIa\ \Theta_1 + EocIc \cos \Theta_3 - Ib\ [Eoa \cos (a - \Theta_2) + Eoc \cos (B + \Theta_2)] \dots\dots\dots\dots (24)$$

From the vector relations of Fig. 22 it may be seen that,



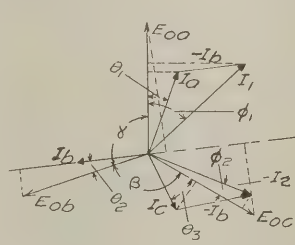


FIG. 21. FIG 22.

FIG. 21. CONNECTIONS OF CURRENT TRANSFORMERS AND CURRENT COILS OF WATTMETER. FIG. 22. VECTOR RELATIONS IN THE CIRCUITS OF FIG. 20.

$$Eoa \cos (a - \Theta_2) + Eoc \cos (B + \Theta_2) = - Eob \cos \Theta_2.$$

Substituting this value in the expression for the sum of the wattmeter readings, $W_1 + W_2 = EoaIa \cos \Theta_1 + EobIb \cos \Theta_2 + EocIc \cos \Theta_3$, which is the total power under all conditions of the circuit, for symmetrical or unsymmetrical systems, employing a fourth wire.

To sum up the results of this discussion it has been found that the following methods are correct.

METHOD.	SYSTEMS FOR WHICH METHOD IS CORRECT.
4-wattmeter	All 4-wire systems, all conditions of the circuit.
3-wattmeter	All 4-wire systems, all conditions of the circuit.
	All 3-wire systems, all conditions of the circuit.
2-wattmeter	All 3-wire systems, all conditions of the circuit.
	Symmetrical quarter-phase systems, on balanced loads.
	Two-phase 4-wire systems, phases independent.
2-wattmeter and 3-current Transformers	All 3-phase, 4-wire systems, all conditions of circuit.
1-wattmeter	3-wire three-phase and 3-wire quarter-phase systems, with balanced loads, all power factors.
	Single-phase two-wire systems.

New Record Made in Foreign Commerce of the United States in the Fiscal Year 1912.

The foreign commerce of the United States made a new and remarkable record in the fiscal year just ended. The total value of the merchandise entering and leaving the country in its trade with foreign lands and its own island possessions in the fiscal year 1912 was 4 billion dollars. The value of manufactures exported was more than 1 billion dollars and the value of non-dutiable merchandise entering the country was one billion dollars. Of this one billion dollars' worth of non-dutiable merchandise entering the country during the year ending June 30, 1912, about 900 million dollars' worth was from foreign countries and 100 million dollars worth from Hawaii and Porto Rico.

Of the more than one billion dollars worth of manufactures exported during the year, those of iron and steel aggregated about 275 million dollars in value; copper and mineral oils, each more than 100 million; lumber and other manufacturers of wood, nearly 100 million; leather and manufactures thereof, about 60 million ;and cotton manufactures, about 50 million. Manufactures exported in the month of May amounted to 108 million dollars for the single month and formed 63 per cent of the total domestic exports of that month. For the full fiscal year manufactures formed about 46 per cent of the total domestic export. During the 34 months in which the present tariff law has been in operation, manufacturers exported averaged 75 million dollars per month and formed 45 per cent of the total exports. During the entire existence of the Dingley law they averaged 46 million dollars per month and formed 37 per cent of the total exports; during the entire operations of the Wilson law exports of manufactures averaged 22 million dollars per month and formed 29 per cent of the total exports; and during the existence of the McKinley law they averaged 16 million dollars per month and formed 21 per cent of the total exports.

Central Station Management, Considering Physical and Commercial Features

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)
BY C. H. BROWARD.

IN the engineering and mechanical departments the duties of the men are more or less specific and each man a specialist in his own line. These departments having the physical efficiency of the company under their supervision, determine in a large measure the attitude of the public toward the company, and the rates at which the company can afford to sell its products. The members of these departments should be always alert to detect any irregularity, or possibility for improvement. As already mentioned, records showing the performance of all apparatus should be kept up to date, showing also the condition of same as disclosed by periodic inspection. These regular inspections and reports of same should be insisted upon and kept so that instant comparisons can be made if necessary. Good mechanics are often unsystematic and careless in regard to reports, records, etc., and these are apt to be neglected unless the office watches for them.

OPERATING DEPARTMENT.

The quality of service given is of prime importance, and hence the operating department should have very careful attention. Its head should be a man of undoubted capabilities; energetic, tactful, and able to handle men to good advantage, for here is where the service is given by which the company is judged. An alert, well trained, and enthusiastic operating force goes a long ways toward giving uninterrupted service, which should be the aim of every company. The personnel of the operating force will naturally be changing often by the coming of new men and the going of the old ones. Therefore, the department chief has to be constantly training new men, and must be forever vigilant if the operating staff is to be maintained at a uniform efficiency. No employee should be retained who cannot satisfactorily fill the position for which he is engaged, no matter how willing or anxious he is to do what is right. If he is out of place it is an injustice both to himself and the company to keep him. Often he can be transferred to another department, where his particular abilities can be used to advantage.

The switchboard operators especially, and as a matter of fact all of the men, should know the different circuits in their station and the location and wiring of all auxiliary apparatus, such as relays, pilot signals, instruments and instrument transformers, potential regulators, etc. Drawings giving all of these particulars should be in the operator's desk for easy reference, and not allowed away from there except for special use. An effort should be made to have a place for every tool and keep all of them where they belong. They will then be easily found if wanted in a hurry. It speaks well for a station to have all details well cared for, with the floors and machines clean, windows bright and brasses polished. These items can easily be attended to during periods of light load by the regular men and thus save extra labor.

In the boiler rooms a capable head fireman will save many times his salary in fuel, and will operate the plant to a higher efficiency, which, in the end, means less equipment for the same output, smaller fixed charges on the investment, and lower maintenance costs. In the meter department the employees come into closer contact with the public than in any other department of operation, and care should be taken to impress them with the responsibility of their position in this respect. A meter man who is too fractious or disagreeable to the customers should be assigned to work in the shops as much as possible, and those whose duties necessitate their entering customers' premises should always be courteous and polite and follow tactfully the company's policy of handling complaints. It is unquestionably best to settle all differences and handle all complaints at the office, where it is possible to give the customer better attention than the average meter man is capable of doing. The company should endeavor to convince its customers that it proposes to keep its meters correct, and if a customer is dissatisfied concerning the accuracy of his meter, a comparison between a new one of the same type placed alongside the old one is usually sufficient to convince him. Then, instead of being a disgruntled customer, his opinions will often be changed by the fair treatment shown him, and another asset will be added, namely, "good-will."

THE LINE DEPARTMENT.

The line department is a branch that is too often neglected, but it should receive just as careful and intelligent supervision as the others. Requests for new service connections, old services to be transferred, blown section and transformer fuses, and all other details should receive prompt and satisfactory attention. Overloaded transformers and circuits should be sought out and remedied. No temporary work should be allowed except in emergencies, as it is well known that such work is anything but "temporary," and in many cases is never changed until it gives way. Complete, accurate records, including maps showing the layout of the lines, location of transformers, section cutouts, and all other important information should be available at all times.

Transformers should be inspected, the oil tested according to some system, and the oil changed when necessary. The experience of some companies indicate that their losses of transformers by lightning has been diminished by this precaution. Local conditions will, in large measure, determine the frequency of such tests and changes. Small companies will do well to avail themselves of the manufacturers' permission to return damaged transformers to the factory and get new ones for the cost of repairs to the old ones, or it is sometimes better to buy new coils from the factory and replace the old ones, thus saving freight and labor costs. Factory wound and impregnated coils are

always to be preferred to those wound in repair shops, and even large companies will find it advantageous to buy the coils from the factory if they are not prepared to impregnate them. In the smaller companies the men naturally have a greater variety of duties than in the larger ones, and often make their own repairs to transformers, meters, etc., but in this event, a first-class repair man who can be used in several departments will be a valuable addition to the force.

CONTINUITY OF SERVICE.

Continuity of service is of great importance, and depends mainly on two things; namely, first-class equipment, backed by an intelligent, well trained and alert operating force. The operators should be regularly instructed and watched by the chief operator or superintendent, for they cannot be expected to learn everything for themselves without being shown, and instruction cards or booklets relating to the principles and operation of different apparatus serves to familiarize them with details they would otherwise overlook. The care of the equipment is an important factor in the efficient and economical operation of the power house. It is not intended in the scope of this article to go into details regarding the care of the machinery, for such details vary widely with the type of apparatus and operating conditions, but all apparatus should receive attention and nothing should be neglected or taken for granted. If anything wrong is disclosed by the periodic inspections steps should be taken at once to remedy it, and if possible prevent the recurrence of a similar defect in the future. Further, the proper department should be notified in a detailed report as to just what was found out of order and what was done to repair it.

There is a present-day tendency toward the use of automatic alarms and indicators on all apparatus that needs regular inspection, such as thermostats on transformers, oil immersed choke-coils, circuit breakers, high and low water alarms, limit switches, and numerous other devices. These devices are intended to automatically take care of some pre-determined condition, or to notify the attendant at the proper time. They should not be left to take care of themselves entirely, and too much dependence should not be placed in them, for, like everything else, they sometimes get out of order, and failure to properly perform their functions may cost hundreds of dollars. In many cases they should be used more to supplement personal inspection, and should be regularly tested to see if they are working properly. According to statistics, 70 per cent of the accidents in industrial plants are directly due to carelessness or negligence, so it is evident that automatic appliances can be made to serve a very useful purpose, and their use should be encouraged in every power house and sub-station.

A log-book, separate from the daily report, in which are entered all accidents or irregularities of any kind, and a record of inspections and repairs, serves a very useful purpose, and such a record should be in every power house and sub-station. Every accident to employees, or equipment, every failure of any piece of apparatus to operate properly, hot bearings, etc., should be entered in this book, and the irregularity should be traced to its origin and steps taken to prevent a recurrence either to that particular appliance or to any other part of the equipment that could suffer similarly.

HANDLING OF COMPLAINTS.

A properly handled complaint can, in the majority of cases, be turned into a valuable asset. Whenever a customer fancies that the company conceals the real conditions he will lose confidence, and it is just such customers, in large numbers, who foster competition and mold public sentiment against a company. The company may not be always in the right and should be very careful not to adopt an attitude that will keep customers from making just complaints.

When a customer has a grievance he should receive prompt and polite attention, and if his complaint is well founded frank acknowledgment and prompt settlement should be made to him. The company should make the most of the opportunity to impress him with the fact that they try to treat their patrons fairly. The chances are that the next time such a customer complains he will be more ready to accept an adverse decision than if his former complaint had been handled in such a manner as to make him feel ill at ease. It is human nature to appreciate a proper interest in our affairs, and if the serving company will maintain closer relations with its customers and convince them of an intention to give the best possible services it will be rewarded handsomely for its pains. Customers should be encouraged to replace blackened lamps with new ones, and any suggestions that the company can make that will show the customers that their interests are mutual will do much toward winning the respect and confidence of the public and will undoubtedly result in many new customers.

SECURING NEW BUSINESS.

New business comes to a service company in at least three ways; first, because the customer needs the service and applies to the company to furnish it to him. This class includes those who have formed favorable opinions of the service through their friends and neighbors, and from noticing its advantages elsewhere. Next are those customers secured as the result of advertising in various forms, and lastly, those whose business is secured through direct solicitation on the part of the company. Every city has a large number of people who belong to this latter class, and the company must necessarily make systematic efforts to secure this business. In order to do this it is necessary to maintain a good corps of wide-awake, up-to-date salesmen—for such they really are—who can convince prospects of the advantages of electric service, both power and lighting. In both fields there are various forms of competition, so the soliciting department should have available data relating to other forms of light and power and be always ready to show the superiority of electric service.

The details relating to the organization and operation of a contract department should be carefully thought out and planned to meet the requirements of the particular locality, but, in general, a complete system of records and follow-up methods, and energetic, intelligent solicitors should be employed. When conditions warrant the solicitors should be divided into light and power salesmen, each specializing in his own field.

In what has gone before, it will be readily seen that particular stress has been placed upon harmony and co-operation in the management of public service companies. This policy is not only confined to successful public service companies, but holds in all businesses, the degrees of success depending upon how far this policy has been carried.

The Requirements and Operation of Circuit Breakers

(*Contributed Exclusively to* Southern Electrician.)

BY C. C. BADEAU.

FOR the purposes of this article, electrical machinery will be divided into four general classes: (1) Apparatus for the generation of electricity. (2) Apparatus for the transmission of electricity. (3) Apparatus for the transformation of electricity. (4) Apparatus for the conversion of electricity into mechanical, thermal, visual and chemical energy requiring varied apparatus.

In the various circuits between these classes of electrical apparatus and controlling each, are many constructions such as circuit breakers, or switches which may be either automatic or non-automatic, generally known as protective devices. The devices control the many varied characteristics of the connected apparatus. For instance, a circuit breaker which is connected between the generator and the transmission line feeding a transformer, which transformer supplies a motor, has to take care of the various characteristics which pertain to each of these three classes of apparatus.

In the selection and design of circuit breakers, the mechanical and electrical characteristics of the breakers themselves must not only be considered, but also all of the characteristics of the entire line, from the time the current is generated until it is finally transformed into various forms of energy. It is this fact which makes the problem of protective devices and circuit breakers such an important, serious and difficult one, and no description of them can be complete which does not take this into account.

The way then to determine the requirements of a protective device for the protection of apparatus is to study the characteristics of the apparatus supplying or receiving the energy and see how well the device takes care of these characteristics. Thus for instance a circuit breaker for industrial plants must take care of certain important general lines of protection. The great majority of circuit breakers for this class of service are used for protecting motors or motor driven machinery and on the end of long distance transmission lines, therefore, the device should serve the characteristics of the motors which it controls.

Motors may be divided into two classes, alternating current and direct current, each class having different characteristics and, therefore, each one requiring special protection. In the beginning, an important consideration must be made clear, namely, that the motor must be large enough for its regular duty without the necessity of disconnecting it from the circuit in order to protect it. If the motor is not large enough for its undertaking no protective devices can make it operate satisfactorily or prevent burning out. From these considerations it follows that all motors under normal conditions, must not be disconnected from the circuit and that the circuit breaker must only disconnect the motor when abnormal conditions occur.

Normal conditions do not mean a normal load on the motor or a predetermined over-load, but it means the conditions which a motor has to meet and satisfactorily fulfill, whether that condition means that the motor must temporarily stand 50 per cent. overload, or whether it must temporarily stand 200 per cent. overload. The abnormal conditions for which protection is required are the following: (1) Internal short circuits in motors, due to faulty winding, lightning discharges, and improper handling. (2) The improper use of the rheostat or starting compensator causing an excessive rush of current, which could be regulated by proper use. (3) A sudden heavy overload on the motor caused by foreign matter in gears or belts.

Generally speaking, an overload is not a condition against which motors can be protected with a protective device. Motors, as above explained, must be of a sufficient size to perform their duty and if this duty includes overload, the motor must be of a design to take care of it, for no protective device would be of commercial value which would open the circuit of a motor when an attempt to overload it was made.

The damage which an overload causes in a motor, is to heat it and a protective device will not adequately take care of overloads and at the same time shut the motor down before the danger point is reached, unless the device possesses the heating characteristics of the motor itself, such a device unfortunately has not as yet been constructed. Motors heat in from one to six hours, depending on the size, therefore, time limit devices are not exactly adequate because the time limit device has a maximum element of one minute and a one minute overload is not injurious as far as the motor is concerned.

All the other abnormal conditions mentioned, produce extremely heavy currents in the motor, usually from five to six times full load current, and a plain overload circuit breaker, therefore, which is arranged so that it can be calibrated for at least three times normal current has proved satisfactory in practice. Direct current motors are always provided with a starting arrangement, so that the current taken at starting, is not more than the full load current, and a circuit breaker with a plain overload protection, is therefore satisfactory.

Alternating current motors have characteristics which render them most difficult to satisfactorily protect and may be divided into, single and polyphase types. The single phase and the polyphase commutator type have practically the same starting and running characteristics as direct current motors, and the circuit breaker requirements, therefore, are identical as far as the overload protection is concerned.

The polyphase motor, employing a squirrel cage wound rotor, normally, takes from two to four times full load current to start at full load torque and therefore, some arrangement must be made to take care of this multiplied starting current. There are several ways of doing this. (1) Time limit devices. These consist of fuses, dash pots, bellows and suckers, devices requiring an overload to persist a predetermined length of time before the circuit breaker responds. They all possess the advantage that a sudden rush

of current at starting will not blow the circuit breaker while the same rush of current if continued, will operate the device. All time limit devices of the mechanical type provided with bellows, suckers, etc., are subject to the disadvantages that any accident to the device such as rust, dust in the ports, or hardening of the bellows, not only render the operation of the device much slower than ordinary, but are apt to keep the breaker from opening at all.

The fuse or thermal type consists of a coil shunted by means of an enclosed fuse of comparatively small capacity. This seems to be the most satisfactory of all and possesses the advantages that a very heavy overload will blow the circuit breaker without blowing the fuse, and if the operator forgets to replace the fuses or the fuse becomes disintegrated, the advantage remains that the circuit breaker will open sooner, instead of later, as is the case with the mechanical types of devices. This coil and fuse type of device is also cheap, simple and has no movable parts. It has the disadvantage that fuses must be employed, and that the accuracy of the breaker is no greater than the accuracy of the fuse and that if the breaker operates often the fuses must be constantly replaced.

(2) Circuit breakers with special protective devices for starting. These circuit breakers have a standard coil with a tap brought out of the coil so that two-thirds of it can be short-circuited when the starting compensator is in a starting position. This means that it will take three times the current to blow the circuit breaker when on the starting point, as it does on the running point, and that the ordinary starting current will therefore not open the breaker.

(3) Holding the tripping armature. This consists of putting the finger on this armature during the starting and taking it off after the motor has come to speed. While crude, this method is certainly effective and in practice has proved of value where the breaker is in a position to be easily reached. The time in which the circuit breaker is kept from opening by the overload is entirely at the control of the operator, and no extra devices are required, the power produced by a complete short-circuit on the motor being always enough to pull the armature away from the operator's hand even if his finger is resting on the armature latch.

To sum up the requirements of circuit breakers for the protection of abnormal currents in motors it may be stated that they are always provided with overload devices of one of the three classes above mentioned. Further than this another abnormal condition of motor circuits requires protection, and that is a sudden return of voltage after the current has been cut off, from overload or other accident by opening the main line circuit supplying the motors, and leaving the motor standing still with all of the starting devices and compensators in running position. If the main line circuit breaker which was previously opened is closed, full voltage would suddenly be thrown upon all of the motors without the interposition of the starting compensator. This would cause an abnormal rush of current and while it would open the overload circuit breaker it would at the same time jar and jolt motor and the machinery which it is driving.

No voltage circuit breakers are provided to take care of this condition, which open when the voltage fails and before the motor is started require the compensator to be thrown to the starting position and the motor started in the normal way.

To bring about this operating condition a fine wire coil is usually provided, which is connected directly across the line. As long as there is voltage on the line this coil is energized and keeps the tripping armature in a suspended position. As soon as the voltage on the line fails, the coil becomes de-energized and allows the armature to drop and trip the circuit breaker open. Circuit breakers are also provided with various other trip coils by means of which they may be opened from one or more distant points by the energization of a coil through the medium of a small switch, or button pushed by the operator.

The Function of Series Resistance in Multiple Arc Lamps

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY HAROLD CRAIG.

THE question often comes up as to why a resistance is always inserted in series with the arc in constant potential arc lamps. This problem is often turned aside with the only reason advanced that standard practice and successful operation has made it necessary. It is the purpose of this article therefore to discuss the operation of the multiple arc lamp and determine what principles are the basis of its successful operation.

The average enclosed multiple arc lamp requires about 85 volts across the arc and when connected across a 110 volt circuit, there is a drop of about 25 volts in the series resistance, which is a part of all such lamps. Nearly one-quarter of the energy expended in the lamp therefore is consumed in developing apparently useless heat in the resistance, while the other three quarters is expended usefully in making light at the arc. The reason for the insertion of the series resistance and this waste of energy is that a multiple arc lamp is steadier at the arc, the explanation being somewhat as follows:

The resistance of an electric arc is governed by a peculiar law. It varies immensely as the current passes through it. If, for instance, a certain arc of constant length had a resistance of, say, 29 ohms with a current of 3 amperes flowing, it would have a resistance with 6 amperes flowing of, possibly, 12 ohms. The reason for this is that, with large currents flowing the cross-section of the arc is made greater, hence its resistance decreases. Bearing this law of arc resistance in mind and referring to A, Fig. 2, consider an arc connected directly across 110 volt constant potential mains and assume that it is burning satisfactorily.

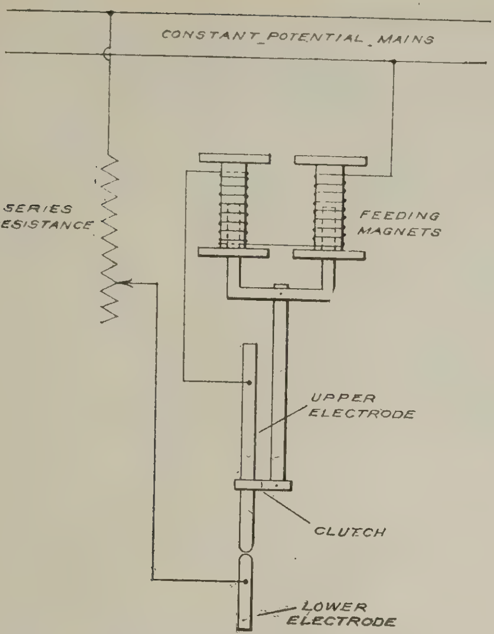


FIG. 1. CIRCUITS OF MULTIPLE ARC LAMP.

If for some reason, possibly because of an impurity in one of the electrodes, the arc current decreased slightly the arc resistance would increase. This would cause a further decrease in arc current and a further increase in arc resistance. This accumulative action would continue until the arc extinguished itself.

On the other hand, if by chance the arc current happened to increase, the arc resistance would decrease and would continue so doing until the current reached an infinite value. It is assumed that absolutely constant potential is maintained on the 110 volt mains. That it is not possible to maintain an arc directly on constant potential mains has been demonstrated experimentally many times. The arc will either go out or will draw an excessive current which will trip a circuit-breaker or rupture a fuse.

If, however, a resistance of proper value is inserted in series with the arc as shown at B, Fig 2, a "stable" arc can be maintained although the voltage drop across it will be considerably less than the voltage of the mains. The series resistance counteracts and corrects the tendency of the arc current to decrease to a zero value or to increase to an infinite value. If the arc current now tends to increase and the arc resistance to decrease, there will be an increase in voltage drop in the series resistance which will help to reduce the voltage across the arc and to reduce the arc current. If the arc current in Fig. 2, B, tends to decrease and the arc resistance to increase there will be a smaller voltage drop in the series resistance and a higher voltage will be impressed across the arc which will correct its tendency to extinguish itself.

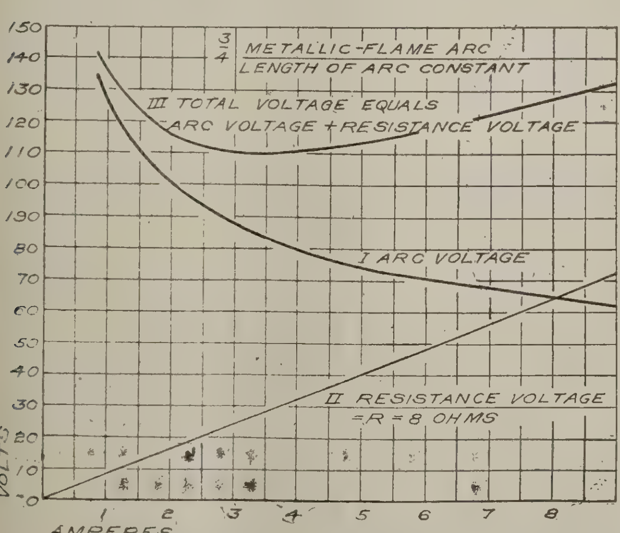


FIG. 3. CURVES OF ARC AND RESISTANCE VOLTAGE.

Any value of series resistance will not satisfy. One must be chosen that is rightly proportioned for the normal current strength of an arc. The principles involved in

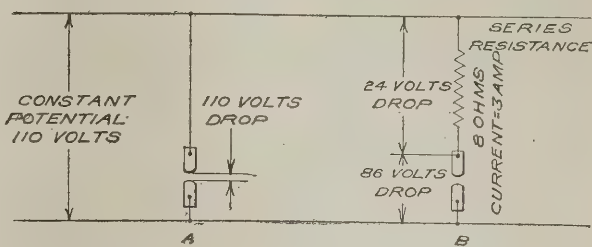


FIG. 2. SHOWING VOLTAGE DROP IN ARC AND RESISTANCE.

selecting such a resistance value are well brought out in the curves of Fig. 3 which were compiled from data from actual tests given in Steinmetz's "General Lecture on Electrical Engineering." The curves are true only for the length and kind of arc noted thereon. Curve 1, arc voltage shows graphically the fact that arc voltage, or arc resistance decreases with increasing current. Curve 2 resistance voltage indicates the direct increase of voltage drop, due to a resistance of 8 ohms, with increasing current. Curve 3 is the sum of 1 and 2.

It will be noted that for the particular arc and resistance under discussion all currents less than about 3½ amperes will tend to cause increasing total voltage drop, curve 3, with decreasing current. While currents greater than 3½ amperes will tend to cause decreasing total voltage drop with decreasing current or increasing total voltage with increasing current. Therefore this particular arc, with 8 ohms resistance in series, will be stable for all currents above 3½ amperes but will not be for currents below 3½ amperes. Obviously the "stability point" will be different for different resistance values. The commercial problem is to select a series resistance value as low as possible, so that the energy loss in the resistance, will not be excessive but at the same time the resistance must always be sufficient to insure a steady arc.

In practice a series rheostat is used in arc lamps as indicated in Fig. 1. This provides for adjustment of the lamp to the line voltage at which it will operate. It is apparent from Fig. 3 that the lamp subject of those curves, can not be operated at a line voltage of less than 110.

In commercial enclosed multiple arc lamps a resistance of about 8 or 9 ohms is inserted in series with the arc. No "steadying" resistance is required in series, constant-current arc lamps because the arc generator or constant-current regulator, which furnishes them with energy, automatically maintains a certain unvarying current strength through the lamps. Because of the fact that series resistances are not necessary in a constant-current lamp it is more efficient than the multiple type.

Telephone Drop Wire Specifications to Subscribers.

(*Contributed Exclusively* to SOUTHERN ELECTRICIAN.)

BY A. TELEPHONE READER.

The drop wires to a subscriber are a very important part of a telephone plant, although judging from examples seen in various parts of the country, many telephone men do not so consider them. To begin with they must be constructed on property not owned or controlled by the telephone company, which makes it advisable if not absolutely necessary to make the drop wire as neat and secure as possible.

Again they must often be run through trees which cannot be trimmed, and the span between the pole and building may be of any length up to one hundred and fifty to two hundred feet. This makes it necessary, in order to furnish uninterrupted service, that the wires be properly placed so as not to come in contact with trees, or if this is impossible to prevent, that they be protected from abrasion at the points of contact and also because of the long spans and the weight of the wire that the wire itself and its attachments at each end be strong enough to hold a considerable strain.

Considering the requirements of the material of which drop wires are constructed, the wire is obviously the most important and should be chosen with the greatest care. It is assumed that wire insulated and twisted into a pair is to be used; it should also meet satisfactorily the following general requirements: The strength of the wire should be such as to admit of its being hung in spans up to two hundred feet in length and support any load of sleet and wind to which it is likely to be subjected. This load will of course vary in different parts of the country, there being no sleet in the southern part and a heavy load, occasionally, in the northern part. With some companies the requirement of strength is met by using a wire satisfactory in other respects, and twisting it around an iron wire between the pole and building. This method has proved very satisfactory.

The insulation of the wire must be permanent and durable and must contain no substance, such as free sulphur, which will act injuriously on the conductor. The insulation must be covered and protected by a thick, strong braiding. The attachment of the wire at the pole end may be made to a double groove insulator on a pin or by use of the same piece of material that is used for making the first attachment to the building. Which ever method is used the wires should be untwisted and laid parallel where they pass around the insulator. The first attachment to the building should be made in such a manner and by the use of such material as will insure a strong, permanent and inconspicuous fastening, with as little damage to the building as possible. The porcelain used must be smooth where the wire comes across it and be so designed that the bend in the wire will not be so sharp as to injure the insulation.

The wire in running along the building should be supported on porcelains placed at intervals short enough to keep the wire from sagging and becoming unsightly. At the point of entrance to the building the wire should be dead ended on a porcelain knob, the wires separated and carried into the building through separate porcelain tubes. All screws and other iron work should be galvanized; the added length of life and neater appearance of the material, making the money paid for galvanizing well spent. All runs on the building should be made either horizontal or vertical, nothing makes an otherwise good drop wire look so bad as the vertical run being a few inches out of the true vertical. The porcelain tubes through which the wires enter the building should slant up from the outside and be long enough to reach entirely through the wall. A drip loop should be formed in each wire.

It may seem an unnecessary refinement but will be found to pay in the end to make all ties and dead ends with a separate short piece of the drop wire, rather than by winding the drop wire around itself to form the tie; as the bends are so short and close together that the insulation is liable to be injured. At the pole, if the drop wire must be run for any distance along the arm, it should be carried under the arm in small bridle rings placed under each pin; if left on the top of the arm and woven in among the pins the insulation is exposed to injury from linemen standing on the arm and also to the full action of the weather. The attachment of the drop wire to the line wire is a very important point and should be done with care, as a loose or high resistance joint here causes much annoyance to the subscriber and is hard to find. A good soldered joint is the safest of all, but any well designed connector, of which there are several on the market, will give satisfaction.

Most telephone men run drop wires about as the man who taught them the trade several years ago told them to, and the result is that there are nearly as many methods of doing the work as there are men doing it, some are very good, some are very bad, and some are betwixt and between. Now if it were given to some man, competent to pass on such things, to determine on the best method of doing this work, for his company and all men were required to follow the same method, the result would soon be that all drop wires in the territory would be uniformly neat and substantial. Drop wires constructed of such material and in such manner as to fulfill the general requirements given above will cost very little more than if made of any material that happens to be at hand or is cheap in first cost.

The good-will of its subscribers is a great asset to any telephone company and the difference in the feeling of the subscriber towards the company when the old drop wire, which was fastened to brackets and looped half way around the building and diagonally down to the entrance, is replaced by a neat twisted pair properly run, is often worth the cost of making the change.

Voltage Regulation and Calculation of a Two-Phase, Three-Wire System. Article in July Issue.

In connection with the article on page 295 of the July issue of the above heading, the following corrections are to be noted: On page 295, second column, $\Theta a + \Theta c$ should be Θa and Θc. Fig. 2. at the bottom left hand corner of the vector diagram rIa should be rIb. Fig. 3, a and d should be interchanged and e added on the right hand side of the place marked "open." Fig. 4, at the end of vector 178, the letter should be e (The diagram now has two "C's" on it). Fig. 5, Ice should be Icl. Third line, third paragraph from top of second column, page 296, should read "longer," not "larger."

N. E. FUNK.

Southern Convention News.

Second Annual Convention of Georgia Section of N. E. L. A.

When the second annual convention of the Georgia section of the N. E. L. A. was called to order on Thursday afternoon, August 15, in the main pavilion of the Tybee Hotel, Tybee Island, Ga., the registration list showed an attendance of 75 members and guests. In consideration of the fact that the total membership at this time last year was only 74, the attendance is ample indication of the progress of the body. The total membership now stands at 110.

The convention was formally opened when President Collier introduced Hon. W. W. Osborne, Mayor of Savannah, who extended to the convention as a whole a most hearty welcome. In his address he referred to early electrical developments and especially to the first demonstration of arc lighting at Savannah in the early eighties.

President W. Rawson Collier, general contract agent of the Georgia Railway and Power Company, of Atlanta, who has ably officiated during the past year, responded to the address of welcome in fitting terms. He then delivered the annual presidential address, in which he reviewed in a general way the work of the section, showing that added interest and enthusiasm had attended the second year of its life. He further referred to the progress of central stations in the southwestern section mentioning the development and growth of steam and water power systems.

He proposed the election of several committees to carry on investigation work between times of executive committee meetings important among which was a committee on rates and a committee on power data. The growth and usefulness of the general correspondence committee was outlined showing that various member companies had taken advantage of this means of securing advice and information on particular subjects from other companies.

A very important development both to the Georgia section and the stations of the Southeastern states was taken up in some detail by Mr. Collier, namely the formation of a Southeastern section of the N. E. L. A. He explained that this was not a new movement but one which he had favored and advocated for some time, believing that its existence would add to the good work of the various State associations now in existence and permit the carrying out in the fullest way any plans that might be of interest to any and all stations in the States it might include.

Following President Collier's address, the report of the membership and finance committee was read by T. W. Peters of the Columbus Railroad, Co., Columbus, Ga. This report gave a present total membership of 110 against 74 for last year. The increase has been by classes as follows: Class A, 2; Class B, 22; Class D, 1; Class E, 11. The total membership by classes is Class A, 16; Class B, 60; Class D, 2; Class E, 32.

Following the reading of the above report, the first paper of the meeting on, "The Present Status of Electrical Vehicles in the Southeastern States," was presented by A. N. Bentley, district manager of the Electric Storage Battery Company. An abstract of this paper follows:

THE PRESENT STATUS OF ELECTRIC VEHICLES IN THE SOUTHEASTERN STATES.

Three different business interests would be benefitted by an increase in the sale and use of electric vehicles. The electric vehicle manufacturer, the storage battery manufacturer and the central station. The central station being in the best position of all for without any extra investment in machinery or equipment, it secures an income of from $5.00 to $50.00 per month from every electric vehicle drawing power from its lines. This load, moreover, is an "off-peak" load of the most desirable character and continues from month to month, as long as the vehicle is kept in operation. The vehicle manufacturer must make his profit on the original sale; the battery manufacturer must maintain a large and expensive selling organization and service department, while the central station spends nothing and reaps the giant's share of the reward. It would appear, therefore, that the up-to-date central station manager would be willing to spend considerable effort and some money toward promoting the sale and use of electric vehicles.

Mr. Bentley carefully outlined the feeling and prejudice to ward electric vehicles created by the older types and voiced the opinion that central station managers do not have enough faith in the modern vehicle and further do not spend the necessary effort and money to get the business on their lines even though they realize it is profitable. He then outlined the progress of the Georgia Railway and Power Co., of Atlanta with electric vehicles. This company has advertised the electric vehicle in the public press, it has purchased and operates three commercial vehicles in its own service and one in the service of the Atlanta Gas Light Company. Its contract agent recommends the electric truck to prospective purchasers of gas trucks, and his recommendation carries the weight of apparent disinterestedness, backed by the example of his company in using electric vehicles of its own.

In addition to these influences, the company's battery expert, who has charge of the large sub-station battery, makes regular inspection of many electric vehicles, housed in private garages. In the authors opinion, the work of this man is very largely responsible for the rapidly increasing popularity of the electric vehicle in Atlanta. He locates and corrects incipient battery and mechanical troubles and instructs the owners in proper methods of charging and operating their vehicles.

In the last two years, approximately eighty new pleasure vehicles and eight commercial machines, of the electric type, have been placed in operation on the streets of Atlanta. The number is rapidly increasing, making it possible for one dealer, formerly a gas-car man, to operate a garage especially equipped for handling electric vehicles. A second dealer has practically given up his gas-car line in order to devote his entire time to selling electrics. The necessity for central station supervision is constantly decreasing and will finally cease altogether.

Going back from Atlanta of to-day, to Memphis of a year ago, there was no garage where an electric was welcome; no competent battery man; a considerable number of antiquated machines, constantly in need of repairs, a source of annoyance and expense to their owners. These adverse conditions were too much for many owners and the number of electrics on the streets of Memphis was rapidly diminishing when the Memphis Consolidated Gas & Electric Company decided to take some action. Their decision resulted in the opening of a garage, in their own name and under their own management, exclusively for electric vehicles. They have certain fixed charges for services, which are as follows:

Full service	$25.00 per month
Full service less delivery	20.00 per month
Vehicle care and oiling	10.00 per month
Battery Care	7.50 per month
Trucks, 1,000, lbs. to 3,000 lbs., full service	20.00 per month
Charging current on above contracts	.05 per Kwh.
Charging current (no contract $1.00 Min.)	.10 per Kwh.
Dead storage	7.50 per month
Wet storage	12.50 per month
Single wash, day, $1.00—night, 75 cents	
Battery and car labor per hour	.75
Single call or delivery	.25

In eight months after opening this garage the company has been forced to increase its floor space from 6,500 square feet to 11,500 square feet. It now has 26 charging plugs and a daily load of over 600 Kwh. They are charging 11 commercial vehicles and 34 pleasure cars. All but two of the commercial

machines have been sold since the garage was opened, as well as fifty new pleasure cars, doubling the number of active electric vehicles in the city of Memphis in less than a year.

In those cities where there are no electric vehicles at present the author of the paper suggests the following action on the part of the central station. (1) The central station should take the first step by purchasing an electric vehicle for its own use. This machine could be of either the commercial or pleasure type as circumstances dictated. Having purchased a machine, the central station would be compelled to provide charging facilities, which could be used by the electric vehicle agent. (2) The central station should train one of its own men in the care of its own machine and the services of this man should be made available to pruchasers of new electric cars, either gratis or for a nominal charge. He should instruct them in the care and operation of their machines, and see that they gave good service. (3) The central station should be willing to stand a portion of the expense of shipping the first cars to its city. It should explain the advantages of electric vehicles to local citizens, who ought to own them, and line up a few prospects for the electric vehicle agent to work on. It should explain to the prospective purchaser its willingness and ability to take care of his car, if he should purchase one.

If the central station went that far, the electric vehicle agent would do the rest, and local dealers would soon take up the work. At the present time there are over 20,000 electric vehicles in service. Of this total, about 30 per cent were sold last year. At the same rate of increase, 6,000 new vehicles will be sold this year. These new vehicles will bring an increased revenue to the central stations of between $50,000 and $75,000 per month.

Mr. Bentley's paper was thoroughly discussed by E. S. Roberts, manager of the commercial department of the Savannah Electric Co., T. W. Peters, commercial agent of Columbus Railroad Co.; J. S. Bleecker, manager Columbus Railroad Co.; E. C. Deal, general manager of Augusta-Aiken Ry. and Electric Corporation, M. L. Sperry, manager of Savannah Electric Co., and W. R. Collier, of Georgia Railway and Power Co.

Mr. Roberts referred to the conditions in Savannah and related experiences with electrical vehicles in that city. He outlined the recent activity of an electric garage and the work that has been done in repairing and placing back into service 56 old cars. There are now something like 80 electric vehicles operating in his city, 12 new machines being sold through his department. Savannah is one of a few Southern cities that has a thoroughly equipped electric repair garage. In closing he urged more cooperation in repair work between manufacturer, central station and customer.

Mr. Bleecker and Mr. Peters commented on the work done in Columbus during the past month to push the electric vehicle business. A car has been purchased, a garage built, a man sent to the factory to learn battery care details, and considerable activity put forth toward creating a demand for vehicles.

M. A. Watterson of the Baker Motor Vehicle Co., took up the matter of cooperation suggested by Mr. Roberts, of Savannah and stated that his company is now in a position to extend such. He outlined the work possible for the central station to do with electric vehicles referring to the extensive work now being done by the Public Service Corporation of New Jersey.

Mr. Deal, of Augusta, commented upon the electric vehicle situation in his city and voiced the opinion expressed by Mr. Bentley in his paper that the central station must first have confidence in electrics and own and operate them themselves in order to sell successfully. He also stated that the central station further than using them as an example, should see that they are maintained in operation and given proper care for some time after the sale so that prejudice is not created by poor operation due to inexperienced attention.

Mr. Sperry, of Savannah, stated that about 4 new trucks are to be soon placed in operation. Following Mr. Sperry, Mr. Roberts of his company suggested that a committee be appointed to gather electric vehicles operation data from Southern stations. Mr. Collier closed the very interesting discussion on this subject by referring to the work being done at Birmingham, Ala., where electrics are being pushed and a large number sold.

The second paper of this session was on the Synchronous Condenser, and presented by H. E. Bussey, resident engineer for General Electric Co. An abstract follows:

THE SYNCHRONOUS CONDENSER AND THE CORRECTION OF POWER FACTOR.

In opening his paper Mr. Bussey took up the characteristics of the load on the average central station system. He showed that the power factor of most industrial motor driven plants is from 60 to 85 per cent where the induction motor is used and further remarked on the effect of series arc lamps with a power factor of 70 to 75 per cent and of multiple arcs with a power factor of 70 per cent as well as the effect of lightly loaded transformers.

The effect of low power factors on the generating station is perhaps the most objectionable of any part of the system. Considering first the effect on generators, the regulation is most seriously affected by lagging current, a generator having a normal regulation of eight per cent at unity power factor will have a regulation of 22 per cent at .8. The limit of generator output is voltage regulation and the highest temperature its insulation will stand without undue deterioration. The temperature rise of a generator is a function of the losses in the machine. Low power factor operation greatly increases the losses and if the attempt is made to maintain the energy output on a generator at low power factor both the copper loss in the station and the field losses are greatly augmented over and above what they should be if the generator were operated at 1. power factor.

The improvement of power factor not only means that the electrical apparatus is operating at better efficiency but also permits of the operation of prime movers at their best load factors and thus greatly aids in the improvements in station economics. In some of the older plants the relative capacities of prime movers and generators have been chosen on a basis of unity power factor where the power factors of the loads that these plants serve is rarely over .8. In such plants a great deal of money is tied up in useless prime mover capacity as long as they are operated under low power factor.

In a number of moderate sized plants where the output per unit is a relatively large percentage of the total station output it is necessary on account of generator heating to operate several units with the prime movers only partially loaded. With improved power factor one or more units may be shut down permitting the steam or water driven units to operate at nearer their best point of economy. This is true to a large extent of all stations whether large or small. Transformers are effected less as regards voltage regulation than generators by low power factors. A transformer whose regulation at 1. power factor is 1 per cent will be 3 per cent at .7 power factor.

The limit of capacity by heating is the same in all electrical apparatus when operated under low power factors. If a generator's maximum capacity as regards heating at unity power factor is 1000 Kw. at .9 it will be 900 Kw. at .8 800 Kw. with approximately the same heating. The same is true of transformers, switches, etc.

The field will not generally be capable of standing the excitation necessary to hold up the voltage at .8 power factor full energy output unless the machine is designed with this in view, and in most cases the excitation voltage cannot be raised high enough to force the necessary excitation through the fields, due to limits of exciter voltage.

A synchronous motor run light is purely a synchronous condenser and has the property of altering the phase relation between the voltage and the current, the direction and extent being dependent on the field excitation of the condenser. It can be run at 1.0 power factor and minimum current input or it can be over excited and thereby deliver leading current which compensates for the inductive load of other parts of the system. A synchronous condenser is virtually a generator electrically geared to the system. Unlike other generators it does not put into the system any power but supplies only magnetizing current to the load, leaving the generators free to supply the energy current. The limitations as regards speed and characteristics usually considered objectionable in generators are not as narrow in the design of a machine used solely for synchronous condenser work. Such machine may have small

air gap lessening the amount of field copper, and comparatively high armature reaction constants and moderate speed, all of which permits of the design of an inexpensive machine without sacrificing the value as a condenser.

It is often desirable to utilize a part of the capacity of a synchronous condenser as a motor to furnish mechanical power as well as exercising a corrective influence on power factor. In such cases the amount of mechanical energy furnished by the condenser is purely dependent on the amount of work the condenser is called on to perform, and the energy current taken from the system is nearly proportional to the mechanical load. The amount of wattless leading current furnished by the condenser is dependent on the field rheostat adjustment. The resultant of these two components is the current read on the ammeter and of course this value must be kept at or below a safe load. It is desirable that the energy load be placed at .7 of the Kva. rating of the motor, this leaving .7 of the capacity of the machine for use as a condenser while taking full Kva. load from the line.

Where a synchronous machine is used as a motor and condenser it is belted or direct connected to its load in the same manner as any other motor and it is usually started the same as an induction motor using an auto transformer compensator. The revolving field is equipped with squirrel cage windings which serve the two fold purpose of increasing starting effort and better stability when running.

In figuring on the installation of a condenser for correcting power factor troubles, a careful survey of the conditions should be made with a view to determining just what these troubles are and to what extent they can be remedied by the presence of leading current in the system. It is necessary to possess a thorough knowledge of the system, covering the generating capacity in energy and Kva. average and maximum load and powerfactor on the generators, average and maximum load and power-factor on the feeders, system of distribution, etc. The desirable location of a condenser is, of course, nearest the inductive load in order to avoid the transmission of the wattless current, but it often happens that a system is so interconnected and the inductive load so distributed that one large condenser cannot economically meet the conditions, in which case it may be better to install two or more smaller ones.

The question of suitable attendance should also be considered and, for this reason, it may be necessary to compromise on the location. When the location of the condenser has been decided upon and the load and the power-factor within its zone determined, the proper size of the condenser to raise the power factor to a given value can be found.

The synchronous condenser can be advantageously used to correct power factor conditions on the most extensive systems or on shorter lines of isolated plants. Their use will sometimes obviate the necessity for additional generator capacity and again may eliminate complaints of bad voltage regulation. The distribution system is benefitted to the extent of better service to consumers with the same equipment and the same load or the power producer derives the benefit for an increased energy distribution over the same outlay of lines, transformers, etc.

The discussion of the paper was taken part in by E. P. Peck, assistant electrical engineer of Georgia Railway and Power Co., G. K. Hutchins, commercial agent of Columbus Power Co., M. L. Sperry, manager Savannah Electric Co., H. L. Wills, Georgia Railway and Power Co., and H. E. Bussey.

Mr. Pecks remarks were based upon actual data from a large plant where a synchronous condenser is installed. The following is an abstract:

Mr. Peck in his discussion gave some data and details in connection with the operation of a synchronous condenser in a large plant. The average day load in the plant was approximately 2,000 Kw. and the power factor at times was below 60 per cent. The bus bar voltage was very greatly changed when large induction motors were started and loaded. He stated that Mr. Bussey's paper gave the regulation of a generator as 8 per cent, at 100 per cent power factor, and 22 per cent at 80 per cent power factor and further added that the generator regulation at 60 per cent power factor is so bad that he presumed Mr. Bussey did not care to give it.

A 1500 Kva. condenser direct connected to a 200 Kw. exciter was installed in the station. The exciter is for the purpose of furnishing the field current for all of the plant generators. With the condenser in operation, the power factor, of a 2,000 Kw. load, may be raised from below 60 per cent to 100 per cent, but it is usually held at about 90 per cent. The armature current of the generators was correspondingly decreased and the field current was greatly reduced. The improvement in voltage regulation as shown on the station voltage charts are very noticeable.

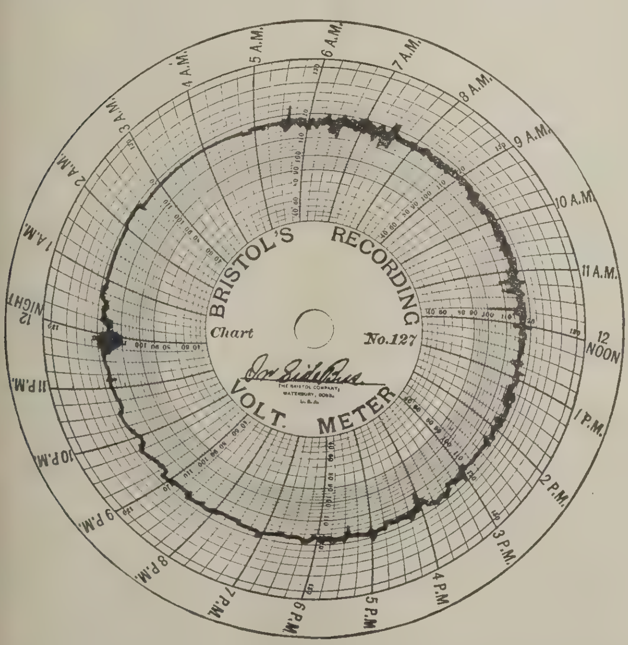
Some readings were taken from the Station Record Report which show the improvement effected.

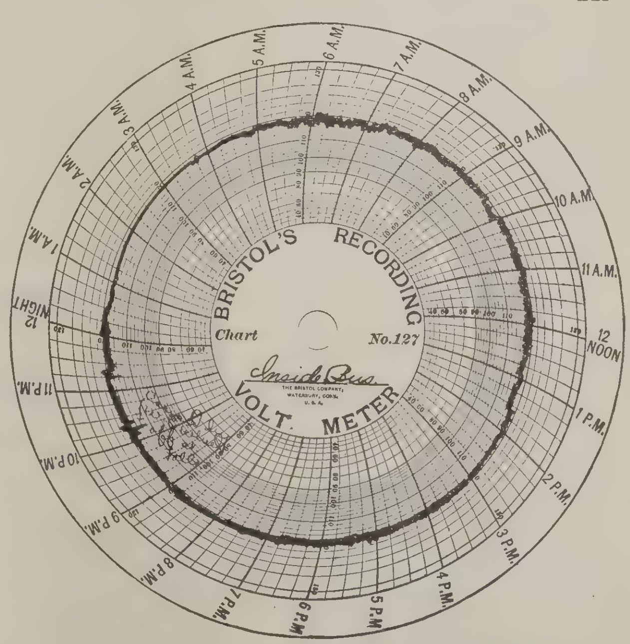
Before Syn. Con. was put into operation.

Amps.	Volts.	Kw.	Power Factor	Field Amps.
718	2350	1750	60%	190
720	2350	1850	63%	198

After Syn. Con. was put into operation.

Amps.	Volts.	Kw.	Power Factor	Field Amps.
463	2350	1750	93%	140
484	2350	1850	94%	145





VOLTAGE CHARTS SHOWING REGULATION BEFORE AND AFTER INSTALLING SYCHRONOUS CONDENSER.

The readings given were taken at times of comparatively light load and at times when one generator was carrying the whole load. When the load becomes heavier, it is necessary to add another generator and the power factor of each generator is dependent largely on its field adjustment. For this reason heavier load readings are not given, although the synchronous condenser is as effective at much larger loads as it is at those given.

When the condenser is running, the exciter coupled to it furnishes all exciting current for the station and the other motor driven exciters are shut down. The energy to be charged to power factor correction is hard to determine. Energy is required to supply the losses in the synchronous condenser set and energy saved in reduced armature copper loss and field loss in the generators.

The following test was made on the synchronous condenser to determine its power factor and its energy loss.

Amps.	Volts.	Kw. Input	Kva. Input	Power Factor	Exciter Output
239	2330	73.9	963	8% (leading)	27.9 Kw.

At the time of test one generator was pulling the station load. Readings were taken on this generator as follows:

Amps.	Volts.	Kw.	Power Factor	Field Amps
475	2330	1690	88.2	170

If the synchronous condenser had not been on, the generator field amperes would probably have been 190. In this case the generator field loss was reduced from 25.3 Kw. to 22.6 Kw. The reduced armature loss cannot well be calculated, without other tests which could not be made conveniently, so this factor has been neglected.

The energy loss in the condenser in this case is then $73.9 - (27.9 + 2.7) = 43.3$ Kw. The losses in the 90 Kw. motor driven exciter which is shut down should also be deducted from the power charged against the condenser. Assuming this loss to be 10 Kw. the energy expended for power factor correction is 33.3 Kw.

At a cost of one cent per Kw. hour, the cost of power factor correction is then 33.3 cents per hour. If it were possible to compute the saving due to working the engines at more efficient loads at some parts of the day, the cost of the power factor correction would reduce to almost nothing.

Most of the readings given above were taken from regular readings of the switchboard meters by the station men and it will be found that the figures do not check in all instances. The results are close enough for practical purposes however, and as a test made with standard instruments throughout would take some time, the switchboard readings are used.

Mr. Hutchins reviewed the conditions in Columbus plants where primary synchronous motors were installed and a contract called for a power factor of 93 per cent. This has however been changed to 90 per cent and contracts specify that for all loads below, the basis of charge shall be on Kva. instead of Kw. Only one customer on the lines at Columbus has a power factor below 90 per cent that varying from 85 to 87 by a proper load on the induction motors.

M. L. Sperry stated that a 1,000 Kva. synchronous motor set is to be installed in the new plant at Savannah and two motor generator sets in Edison substations one of 750 and one of 500 Kva. giving a total capacity of 2250 Kva in synchronous apparatus to correct power factor.

Mr. Wills referred to the proper location of synchronous condensers stating that the nearness to the inductive load improved the speed regulation with a fluctuating load on motors.

H. E. Bussey suggested that a very material advantage of the location suggested by Mr. Wills was to be obtained through saving of copper and in sizes of all other apparatus. He stated however that on account of the small units often demanded by such location it was not always feasible and that larger sizes were therefore often placed in the station.

The report of the committee on power data was next read by H. L. Wills. He made a number of suggestions for the work of such a committee and outlined a form to adopt to secure and file such data. This form would contain in convenient shape, name of the Company, sizes of motors use, arrangements of motor drives, kinds of motors, voltage, power consumption in Kw. per month, number of hours in operation, output in the commercial units of the particular plant considered, shaft and bearing data and machine data.

Mr. Hutchins suggested that the consumption of power, for a particular unit of any plant, over a period of a year would permit a reliable estimate on other similar plants and believed this should be borne in mind when securing the data.

SECOND SESSION.

The second session was called to order on Thursday morning at 10 o'clock and the first paper on "A Mechanical Collector, its Offenses and Defenses ," presented by the author, T. W. Peters, commercial agent of Columbus Railroad Co., An abstract follows:

A MECHANICAL COLLECTOR, ITS OFFENSES AND DEFENSES.

It certainly behooves the electric company to take care of their small customers, yet while taking care of the small customer, it certainly is not policy for the company to lose money on account of poor credits, or on account of the cost per customer being so high that the company loses money on each sale. The logical way in which to accomplish this seems to me to be by the use of the prepayment meter, or as we may term it, the mechanical collector.

The use of the prepayment meter eliminates the meter reader, and also a collector, but it necessitates hiring a man to "rob" them. The cost of robbing the meter will not be more than the cost of collection, if as much, because when a man robs a meter he only has to make one call.

The author of the paper stated that certain objections are given against prepayment meters among which are the following: 1. Lack of money of right denomination. 2. Gearing cannot be set for service sold on sliding scale. 3. Money hung in meter. 4. Use of checks in place of money. 5. Robbing of meter either by dishonest collector or public. 6. Accounting Department, on account of money and readings not balancing. 7. Minimum charge. 8. Tendency to reduce bills, 9. Higher cost of meter. He took up each of these objections showing through his own experience that in most cases they were not serious and could be satisfactorily handled.

He further stated use of prepayment meter does not necessarily reduce bills for fully 90 per cent of the prepayment meters in use in Columbus, Ga., are five ampere, from which is received during a period of twelve months an average of $29.00, the other 10 per cent are 10 ampere and 15 ampere, and do not bring any more money than the five ampere meters on an average. Taken at random 25, five ampere straight meters, we find that the revenue received from these meters averaged $28.00 per annum. This difference in revenue received on straight meters and prepayment meters if capitalized at 6 per cent would more than equal the cost between the straight and prepayment meters.

If, under ordinary circumstances, it is good policy to build an extension to any customer, who will guarantee each year a gross revenue equal to the cost of the extension, it is certainly good business policy to pay from 40 to 50 per cent more for a meter to get a customer on the existing lines, especially when the extra cost of the meter does not amount to more than $5.00 at the maximum. Another big thing in favor of the prepayment

meter, in my mind, is that it does away with the customary $5.00 deposit.

It will be found in practice that only a certain class of people will be required to use prepayment meters. This class can always be determined by local conditions. It will also be found that practically all customers with a connected load of 2 Kw. or more are persons who are, either, financially responsible, or conduct a class of business which is required to pay cash for everything they get.

Prepayment meters have made it possible in Columbus to get and keep a certain class of customers, which before its advent were difficult to secure, namely the mill operative and the negro. It has been the experience in Columbus, from observation, that this class of customers burn light in the morning as well as at night. The average installation is about four 16 Cp. equivalents. Two lights are usually burned in the morning for about two hours, and at dusk the maximum load is about three 16 Cp. equivalents, which burn until after supper. After supper one light is generally used until bed time.

The prepayment meter has also made it possible for companies to collect old accounts, and at the same time sell customers, whose credit was bad, service on a cash basis. This is done by placing a higher gear on the meters than ordinarily used. The difference at the end of the month between the regular rate and that for which the meter is geared, is credited to the old account.

We have made in Columbus several experiments in the use of prepayment meters, one of which was: We made a proposition to several negroes that we would wire their houses for three lights and furnish them with an iron, provided they would use electricity. The meter for this purpose was set for a 15 cent rate, and the difference between our regular 10 cent rate and the 15 cent rate was credited to the cost of the installation. This did not work out as well as we had expected, as the negroes did not use the electric irons as much as they should. This, I believe, was due to the fact that we charged a too high rate per Kw. hour for wiring. If we had used a 12 cent rate wheel on the meter in place of the 15 cent, I believe that the experiment would have been all that could have been desired. As it is, I cannot recall at the present time any customers that were placed on the lines under the above conditions, who have not paid up in full for all wiring done by the company.

The following took part in the discussion: E. C. Deal, general manager Augusta-Aiken Railway and Electric Corporation, G. K. Hutchins, commercial agent, Columbus Power Co., J. S. Bleecker, manager Columbus Railroad Co., J. E. Bigham, general manager, Tampa Electric Co., and Mr. L. W. Carnegie of General Electric Co.

Mr. Deal referred to conditions on his system where he was yet undecided whether to install maximum demand controlling devices or prepayment meters. He was of the opinion that the prepayment meter is not necessary when a cheap meter can be secured. With the controlling device he favored a flat rate of a certain amount per watt month.

Mr. Bleecker stated that at Columbus 10 per cent of electric and 40 per cent of gas meters are prepayment.

Mr. Carnegie stated the controlling device is a good method to use in starting new customers, finally inducing them to install a straight meter.

The second paper on "Arc Lamps and the more Recent Developments Thereof," was presented by L. A. S. Wood of the Westinghouse Electrical and Mfg. Co. An abstract follows:

ARC LAMPS AND THE MORE RECENT DEVELOPMENTS THEREOF.

The earliest record we have of the electric arc is in a lecture by Sir Humphrey Davey given before the Royal Institution, London, in 1808, when with the aid of a battery of 2,000 voltaic cells he produced an arc between two carbon rods held horizontally. Owing to the shape assumed by the electric discharge due to the upward current of hot air, he called this the Electric "Arch," and later in 1820, when describing the effect of a magnet on the discharge, he definitely named the phenoma the Electric "Arc." With the advent of vertical super-imposed carbons, although the discharge is no longer arch shaped, the name "arc" still remains.

From this time various designs of arc lamps were produced, but it was not until the introduction of the Gramme Dynamo in 1870 that the arc lamp became a commercial possibility. The first installation for street lighting by the electric arc was completed in 1878 on the Avenue de l'Opera, Paris.

The development of the arc lamp may be divided into five distinct periods, viz: that of the open carbon arc, the enclosed carbon arc, the metallic flame arc, the open flame carbon arc, and the enclosed flame carbon arc, and I will deal with them in this order.

The open carbon arc lamp has in America been almost entirely superseded by the enclosed carbon arc, although abroad it is still very extensively used. In this type of lamp the largest portion of light is emitted from the depressed crater, which is formed at the end of the positive carbon and which is forced up to the extreme temperature (3,500°C.), a little light is emitted by the tip of the negative carbon and still less by the incandescent vapor of the arc itself. The lamp is designed for use either on direct or alternating current circuits, the direct current lamp giving the higher candle power for a given energy consumption. In this type (the direct current)) the positive carbon is consumed more rapidly than the negative and this is compensated for by using a positive carbon of large diameter.

The enclosed carbon arc. It was not until Jandue in 1893 produced his enclosed arc lamp that this type came into commercial use. In America it immediately came into almost universal service, but abroad its use is confined to industrial lighting. The character of the enclosed arc differs very radically from that of the open arc. No permanent crater is formed but the arc forms a small crater which wanders slowly over the surface of the positive electrode, leaving its end fairly flat. A smaller proportion of the total light emitted comes from the crater than in the open arc and a much larger proportion comes from the arc itself; this has the effect of giving a more uniform distribution of light and rather in the outward than downward direction.

The average life of the enclosed lamp is from 100 to 150 hours, and they are usually designed to work at a current of from 4.5 to 7.5 amperes with an arc voltage of from 70 to 80 volts. The enclosed carbon lamp is equally successful on alternating current and the A. C. series lamp with a constant current regulating transformer has been up till recently almost universally used in this country for street lighting.

A semi-enclosed lamp taking carbons of small diameter and working at from 3 to 5 amperes with an arc voltage of 75 volts has been used very successfully. The burning hours of this type are from 25 to 30 hours, with an average candle power of approximately 600 for the 5 ampere lamp.

The advent of the flaming arc lamp has completely revolutionized the arc lamp industry and has sustained the arc lamp in its position as the most efficient illuminant, which was threatened by the introduction of the tungsten lamp. As its name implies, the light from the flaming arc is emitted chiefly from the arc itself and not from the highly heated electrodes, as in the case of the lamps previously described.

In this lamp the light is emitted almost entirely by the arc itself, the most brilliant portion of the arc being that adjacent to the pool of molton slag, which forms at the end of the negative electrode.

The metallic flame lamp offered some very difficult problems to investigators, particularly in connection with the heavy deposit of soot from the electrodes. This difficulty has been overcome by a specially arranged chimney which sends the air currents in a downward direction past the arc, sweeping the interior of the globe, and carrying the soot into the open air.

In this lamp the negative electrode is made of oxide of iron, to which is added titanium to make the arc highly luminous and a small proportion of chromium oxide to restrain evaporation of the material. The positive electrode is a composite metallic button, whose oxides when fused into slag form a good conductor when cold.

In order to prevent the electrodes from welding together when current is switched off, they are normally held apart, special coils being provided for striking and maintaining the arc.

The average life of the electrodes is from 100 to 250 hours per trim with lamps designed for currents of 6.6 and 4 amperes, with an arc voltage of 68. The lamp is not made for alternating current and it is usually used for street lighting, in conjunction with a mercury vapor rectifier.

The light from a 272 watt metallic flame lamp is equal to that obtained from a 7.5 amp. alternating enclosed arc lamp, and that from the 450 watt lamp three times as great. The distribution at 10 to 30 degrees below the horizontal is fairly uniform and this permits the lamps being hung well above the direct line of vision, thus eliminating glare in the eyes of pedestrians, and at the same time maintaining a uniform distribution of illumination in the streets.

This paper was briefly discussed by G. S. Merrill assistant to chief engineer of National Electric Lamp Associa-

tion. He suggested that the cost data presented on the operation of the lamps should be worked out more in detail. Fixed charges, interest and depreciation, etc., should be considered for total investment, also the depreciation of candle power in service and the effect of power factor.

The last paper of this session on, "Purchasing coal on the Analysis or Btu. Basis" was presented by M. L. Sperry, manager of Savannah Electric Co., and is as follows:

PURCHASING COAL ON THE ANALYSIS OR B. T. U. BASIS.

Before entering upon a discussion of his subject, the author briefly reviewed the demand for commercial sources of power in the United States. He referred to an interesting article on "The Early Days of Electric Lighting," by Mr. H. T. Edgar, in which he reviews the fact that a little over one hundred years ago Sir Humphrey Davey produced the first electric arc; that but thirty-five years have passed since Thomas Edison began his experiments which produced an incandescent lamp, and that the first Edison commercial station for generating electricity began operating at Appleton, Wisconsin, in 1882. Four months later, the Pearl Street station of what is now known as the New York Edison Company began operating in September, 1882. The dynamo in this station, known as the "Jumbo" dynamo, and invented by Edison, had a capacity of but 1200 16 Cp. incandescent lamps. Each of the new generators in the Savannah Electric Company's new Riverside power station will generate sufficient current to light 100,000 incandescent lamps of equivalent candlepower. The amount of power utilized in the United States in the last forty years has increased practically fifteen-fold, being 2,346,142 Hp. in 1870 and 14,641,544 Hp. in 1905.

Mr. Sperry quoted H. St. Clair Putnam, of New York, estimating the motor energy of all industries now in operation in the United States at slightly less than 30,000,000 Hp. Of this total horse power in 1890, 15,569 was electrical; by 1905 it had increased to 1,150,891 Hp. In 1870 the production of coal in the United States amounted to 33,000,000 tons. In 1910 it reached practically 500,000,000 tons, costing at least $1,250,000,000 in front of the boilers. In all steam plants, fuel costs are a large percentage of the total operating costs. In electric power plants this cost of fuel averages from one-fourth to one-third of the total cost of current at the switchboard.

The usual method of purchasing coal was and still is in many plants to find the most reliable local coal dealer, the man who will keep you supplied with coal under all circumstances, contract with him for a supply of fuel whose price is satisfactory to the management, and whose quality to the chief engineer and firemen. Within the last ten years, the power plant betterment engineer has become known, and the big problem he has had to solve was that of fuel economy in steam stations. An important part of his work was to examine different steam coals; have them analyzed chemically, and determine which coal of certain price and chemical qualities would give the best economy in the station under investigation. With a coal standard set for a plant, a year's contract was usually made for coal of this standard, to be delivered at a certain price. Premiums and penalties were established for coal varying from this standard.

The evident purpose and intent of purchasing coal on the so-called Btu. or analysis basis is to secure a supply of fuel constant as to quality, and to provide compensation for such fuel based on the heat value and approximate chemical constituents of the coal.

This paper was discussed by H. L. Wills, of Georgia Railway and Power Co., E. P. Peck, of the same company, Alba H. Warren, manager of Pensacola Electric Co., and M. L. Sperry.

Mr. Wills stated that coal must be suited to the furnace used and men handling it to get the best of resultts. Also in sampling due consideration should be taken of condition as to wet or dry, etc.

Mr. Sperry referred to the work done and literature available on the subject from the Bureau of Mines, Bulletin 41 being the latest information.

Mr. Warren, of Pensacola stated that his company brought on a guarantee basis through analysis but without penalty other than suspension of contract. Satisfactory results have been secured during past 4 years.

THIRD SESSION.

On Friday evening a session was held at which a paper on electric rates was presented by G. S. Merrill, assistant chief engineer, National Electric Lamp association and the report of the Public Policy Committee. An abstract of Mr. Merrill's paper follows:

ELECTRIC RATES.

In a general discussion on rates it is well to leave out of consideration the actual amounts of the charges made. Whether a company charges 6 cents or 60 cents for a given service is a matter of no particular importance in this discussion since the general level of charges which the station must make for a given service will be affected by innumerable local conditions involving both the cost and the value of the service rendered. By limiting the discussion to the forms of rates the large and the small stations can meet on common ground for the need of simple yet commercially sound and logical rates is as great in the one case as in the other. The size of the community in which the station operates may affect the extent to which service must be classified and the number of rate schedules required to adequately take care of the available business; but the general form of the rates need not be essentially different; commercial rates must be just as technically correct and residential rates must be just as simple and equitable for the small stations as for the large one.

A consideration of the cost of rendering electric service points to the desirability of establishing some differential method of charging that will recognize the independent relation of the fixed and running expenses involved. Moreover, if the cost of service to the consumer is to represent any reasonable relation to its value, as it certainly should, the same two elements must again be recognized in some form of a differential rate. It is impossible to adequately cover the complex cost of service to the station or to establish any equitable relation between the cost and the value of the service to the consumer under a rate which neglects either the fixed or the running expenses. The differential rate, giving the customer the equivalent of a decreased price per unit of energy consumed with increased hours use of service is fully justified by the economic espects of the problem and such rates are to-day regarded by many stations as a vital requisite to their greatest commercial development.

In order to simplify the discussion of rates the users of Central Station service may be broadly classified according to their character and size. In the first group would be the large commercial and industrial consumers of energy for light and power; in the second group, the small customers, principally residential, whose demands in the past were limited to lighting, but who to-day present well recognized possibilities for the development of non-lighting loads; in the third group would be the very small residential customer whose use of service is necessarily limited to lighting only. The same form of rate cannot be applied commercially to these three classes of service. In rates for industrial and commercial service technical analysis of demand and consumption can occupy a prominent part; in the rates for the small customer the psychological effect must be considered and the form of the rate must be modified in such a way that it will meet with popular approval and at the same time establish the charge for service with reasonable regard to both its cost and its value. In the case of the very small customers the necessity of reducing the cost of service to a minimum requires a radically different form of rate than either of the foregoing. The form of differential or demand rates particularly suited for the large, the small and the very small customers will be discussed in the order named.

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Customers of large size can be handled satisfactorily by a rate in which fixed and running charges are made separately. The fixed charges are based on maximum demand, estimated in the case of the consumers of moderate size and measured in the case of the larger consumers. The running charges depend upon the number of K. W. hours consumed each month. Both running and fixed charges are made on a block system that automatically gives the larger demand or larger consumption a lower unit rate without the introduction of steps due to the uneven action of a discount.

The most logical way in which a differential rate could be offered to the small customer would be as a fixed monthly charge based in some manner on the customer's installation and a separate running charge based upon the number of kilowatt hours consumed each month. It is the general opinion that the ordinary small customer in this country would not particularly favor a rate making separate fixed and running charges and a form in which the differential action is secured by a high primary and a low secondary Kw. hour charge has been used in its place. The number of units to which the primary rate applies each month is determined by the size of the installation; the secondary rate applies to all excess energy

consumed in any month. A multiple rate of this character gives the same general effect as the rate making separate fixed and running charges when applied to the average customer, and it is much more acceptable in form. The small consumer dislikes fixed charges; he likes to pay for what he uses based on the monthly reading of his watt hour meter. He should rather, of course, pay for what he gets including service as well as Kw. hours and it is by the automatic action of the primary and secondary charges of the multiple rate that he is made to pay for what he gets on the basis of what he uses.

Ordinarily in a multiple rate it is desirable to have the primary rate as high as possible in order that the number of units to be used at the primary rate may be made relatively small. In this way the fixed charges are quickly covered by the first few units consumed each month and the customer is given the advantage of the secondary rate at a relatively lower load factor. While the primary rate should be fairly high, the secondary rate should be made as low as is consistent with a reasonable margin of profit over the actual cost of energy delivered disregarding the fixed charges which the primary rate should cover. The lower the secondary rate the greater will be the incentive for the customer to use heating and cooking devices.

The method of determining the number of units to be used at the primary part of a multiple rate has been the subject of much discussion. It is generally agreed that the amount of energy to be used at the primary rate should be determined in some way by the lighting service rendered, and that, at least at present, heating, cooking and other current consuming devices should not be counted as increasing the number of primary units for any particular installation. There are two principal methods to be considered by which the consumer's required primary consumption may be determined; first, the method using estimated demand based primarily upon the connected load; second, the method using floor area illuminated, usually reduced to number of rooms in residential service.

It would seem quite logical and equitable to base the primary rating upon the area or number of rooms illuminated particularly where it is generally recognized that the primary use should be determined by the lighting service only. A statement that the number of units to which the primary rate applies each month is determined from the number of rooms or the floor area illuminated would be more easily comprehended by the ordinary consumer than any statement bringing in connected load, maximum demand and equivalent hours use. The floor area or the room basis method of rating frankly recognizes by its form the existence of both cost and value elements, and having done this, it seeks to perform its function in the most simple and direct manner. Just how involved multiple rate on such a basis need be made in any particular case, will depend upon the character of the community served. From a simple schedule showing the number of Kw. hours required at the primary rate for houses of 6, 7 and 8 rooms, etc., according to the real estate classification, to rates making allowance for different consumptions according to the character and number of rooms with restrictions as to the area to be counted as one room, there is a wide range of choice. The room or floor area basis of rating has been used successfully for some time in Detroit, Milwaukee, St. Louis and in several Canadian and foreign cities. It has recently been adopted in Harrisburg, Pa., and it is gradually gaining favor in many other localities. Experience has shown it to be a thoroughly practical and commercially sound method of charging.

There is still one important class of customers to be considered: The very small residential consumers who have only a few rooms and whose use of service is quite limited. A few stations who have studied this matter with particular care have adopted a flat demand rate for such service.

A controlled demand rate for very small customers would in no way interfere with the regular multiple rate for large users. In one sense it could be considered as an introductory rate designed to secure a more general recognition of the advantages of electric service. After once getting acquainted with the use of electricity for lighting the customer may in all probability some day seek its further conveniences under the regular multiple schedule.

In conclusion a summary of the forms of rates which seem particularly adapted to the three general classes of customers will be made. Experience has shown that for large commercial and industrial customers the two charge block rate making separate fixed and running charges is simple, equitable and satisfactory. For the small customer the multiple rate has been found uniformly satisfactory and well designed to develop profitable, long-hour use of service. In spite of the complicated method by which some multiple rates have determined the primary consumption they have been introduced with but little trouble. By the use of floor area or number of rooms the multiple rate can be made both simple and equitable, and in view of the ease with which the more complicated forms have been adopted in the past there should be little reason for criticising such rates as being too complex for the ordinary service. Simplified by the use of illuminated area, the many advantages of the multiple rate over the straight meter rate should lead to its greatly extended adoption. For the very small customers the controlled demand rate offers great opportunities of business development, particularly because of the great number of very small prospects within easy reach of the present lines.

Following the reading of the above paper a written discussion was given by J. S. Bleecker, of Columbus, in which he treated the rate problem from the standpoints of principle, practice and policy. Under the heading of principle or theory he defined the different rates now in use. He then showed how business may be divided into three general classes and how a rate for each was effected by present and past practice. He ended his discussion by showing how the rates governed by principle and practice were finally molded into practical shape by policy.

Mr. Merrill offered no objection to the proposals made by Mr. Bleecker stating that in general his remarks agreed with those of his paper. He emphasized in this discussion however that a real advantage was presented in a uniform rate as far as practicable for all central stations, stating that in doing this they would secure in a large measure public approval on the basis of fair dealing everywhere.

Following the closing discussion on the subject of rates, Mr. P. S. Arkwright as chairman of the public policy committee delivered an address on "The Length and Terms of a Franchise," on behalf of the Committee.

He carefully outlined the disadvantages of a short term franchise stating that the practice of accepting 10, 30 and 50 year franchises had the tendency to promote the short term as a regular thing which in most cases could not be tolerated by the central station, where the franchise is as in the State of Georgia of no value except for taxation. In this state it cannot be capitalized yet the value of a central station's physical progress depends upon it. He further stated that while the franchise is necessary for the central station to reach its customer, it is surprising that even with a short term franchise accepted how difficult it is to renew it on a fair and equitable basis. There are conditions added usually in the form of an increased taxation, furnishing the city current at a low rate together with other variations most unfair to a public service company. He referred as examples of this difficulty to Chicago, Cleveland, Detroit and Toledo. Mr. Arkwright emphatically stated that in his opinion the central station cannot and should not accept a limited franchise referring to the steam railways and telephone and telegraph companies which are not required to accept a franchise limited in any way so long as they use the public highways and private right of ways for the purpose originally proposed. He showed that a municipality desires service not for a limited time but always, even in the case of a short time franchise and therefore could not see why a limitation could with all fairness be proposed, and at the same time demand a low rate and the best of service. In Georgia rates are controlled by a railroad commission therefore another reason why a limited franchise should not be accepted by the company and public.

He further showed that with unlimited franchise there is the natural tendency toward reasonable rates, better service and higher taxes. Every central station owes it to the public to give first, good service, and second reasonable rates, the lowest possible to allow the necessary return on

the investment, to which all business is entitled. It further owes the public concessions to all reasonable demands, fair treatment in all cases, should stand its share of public burdens through its portion of taxes, establish good citizenship, contribute to public enterprise and use its influence to build up the community. For all this the central station is entitled to protection against rate wars.

In regard to competition the following are Mr. Arkwright's remarks in part: "While our franchise should not specify any length of time that it should run, it is, of course, held subject to public good will. We can only do business as long as the community is satisfied with our way of doing business, and our right to do business depends upon the continued good will of the community in which we serve, so we will be only allowed to perform this business as long as we desire the right to do it.

If we have to furnish good service to all of the community at a reasonable rate we are entitled to be protected against rate wars and competition by the municipality itself in the form of municipal ownership, for I think if a company spends its money in a community furnishing service when the community itself is unwilling to risk its money, then those who put the money in are entitled thereafter to be protected against heaving that investment confiscated by the government itself going into the business and assessing our property for the purpose of paying its loss in business competition with us."

FOURTH SESSION.

At the Saturday morning session a paper on "Diversity Factor" was presented by W. L. Southwell, commercial engineer of Central Georgia Power Co. An abstract follows:

DIVERSITY FACTOR.

The three factors which determine to a very great extent the relative values to us of the different classes of service are load factor, diversity factor and power factor. Though differing in definition and principle, each of these factors ultimately operates to a similar effect upon the central station, as the consideration given each of them will determine to a considerable extent the investment in plant and equipment necessary for a given volume of output. Power factor is not primarily a subject of this paper, will not be discussed here. Load factor subject of this paper, will not be discussed here. Load foctor and diversity factor, are however, so intimately related that one cannot be properly considered without reference to the other.

The National Electric Light Association Committee on Terminology defines several species of load factors, that is, connected load factor, plant capacity load factor and maximum demand load factor. The maximum demand load factor is most commonly used, and is defined as the "ratio of the kilowatt hours actually delivered by a plant during any given period of time to the kilowatt hours which the same plant would have delivered had it operated throughout the same period continuously at the maximum rate recorded." In other words, load factor is the ratio (in per cent) of the mean load for a given period to the maximum load recorded during that period.

This same Committee on Terminology defines diversity factor as "The ratio between the simultaneous demand of a number of individual services for a specified period, such as one hour, and the sum of the individual maximum demands of those services for the same period." This definition gives a diversity factor expressed in per cent and which can never be greater than unity. This factor, however, is very commonly defined as the ratio of the sum of the maximum demands of a given group of consumers, whenever occurring, to the actual maximum demand made by the group at one time. This definition has been most generally employed, and gives a diversity factor which is of course the reciprocal of the result obtained by the application of the first definition above. Undoubtedly, the definition recommended by the Committee on Terminology is the better, and should be adopted as standard, and will be used throughout this paper.

From the above definitions, the intimate relation between load factor and diversity factor is apparent, and it is obvious that a low diversity factor contributes to, and in practice is largely responsible for, a high load factor. The importance of diversity factor is appreciated when it is realized that a large percentage of the cost of supplying electric service is very frequently made up of fixed charges, such as interest, depreciation, taxes, insurance, etc., and it is obvious that the greater the amount of equipment required to supply a unit of connected load, the greater must be the fixed expense per unit connected.

An exhaustive consideration of this subject involves the study of each link in the chain of service between the connected load and the generating plant, and the determining of the factors which affect the capacity and equipment at each step. The first step is, of course, to determine the demand factor, or ratio of each consumer's maximum demand to his connected load. This will determine the size of meter and service wires necessary for each consumer. Next, in the alternating current system, comes the diversity factor between the various consumers and transformers, which will determine the transformer capacity required to supply a given group or class of connected load. The next step is the diversity factor between the loads of different character, whose maximum demands occur at different times and so on until we determine the diversity factor between the generating station and the various groups of consumers supplied.

The author of the paper referred to results of investigations made by the Commonwealth Edison Company of Chicago to illustrate the importance of diversity, and the value of a thorough knowledge of diversity factors and their application. He showed that a connected load of 100 Kw. in residence consumers in Chicago, each of .3 Kw. connected load, caused a maximum demand at transformer of 30 Kw., a maximum demand at the feeder panel of 16.6 Kw., a maximum demand at the consumers' meters of 90 Kw., and a maximum demand at the time of the sub-station peak of 14.5 Kw. These results indicate a diversity factor between transformers and meters of 33.3 per cent. between feeder and meters of 18.4 per cent and between the sub-station and meters of 16.1 per cent.

The observations made in Chicago were quite exhaustive, and the average results recorded for various classes of consumers are as follows:

Analysis of Diversity Factors.

	Number of consumers	Kw. connected per consumer	Sum of consumers' maxima	Maximum of group	Diversity factor	Average consumer load factor	Group load factor
Residence lighting..	128	.68	57	17.2	36.8	7.1	23.9
Commercial lighting	95	.70	48	33	68.5	10.8	15.7
Genl motor service	21	4.5	65	45	69.5	15.5	26

The above figures show the diversity factor between the maximum demand recorded at the single transformer supplying the group, and the sum of the consumers' maxima. These results indicate that to serve a group of residence consumers the transformer should have a capacity equal to 20 per cent of the total connected load; that for commercial service the transformer should have a capacity of about 50 per cent of the connected load; and that for general small motor service the transformer capacity should be approximately 48 per cent of the connected load. Further analysis of residence conditions shows a diversity factor between the plant and the aggregate of the residence maxima of a trifle less than 20 per cent. In other words, one Kw. of generating equipment will supply a group of consumers, the sum of whose maximum demand is 5 Kw., or, with a demand factor of 65 per cent whose aggregate connected load is approximately 7.7 Kw.

From hydro-electric plant of the system with which the writer of the paper is connected current for lighting and power purposes is supplied to five cities. The diversity factor between these five sub-stations and their respective loads ranges from 95 per cent down to 49 per cent. The diversity between the maximum at the power house and the sum of the maxima of the five stations is 84 per cent while the diversity factor between the power plant and the consumers is approximately 54 per cent. All of these diversity factors are being steadily lowered by increase in the number and diversity of consumers served. With a diversity factor of 54 per cent between the plant and the consumers, and with an installed capacity of 24,000 Hp. consumers can be served on the above system with aggregate demands of 44,500 Hp. With a higher diversity factor, of say 75 per cent to serve this aggregate demand would require an installed capacity of 33,400 Hp. This would mean additional investment of many thousands of dollars.

The influence of diversity factor upon rate-making is obvious, and it would appear that a rate is unfair which is arbitrarily based upon the consumer's maximum demand; without reference to the diversity factor of the class to which he belongs. The problem of rate-making involves the careful consideration of many complicated factors, which in many cases require modification to meet local conditions. The consumer's ambition is to secure either a flat rate or a straight kilowatt hour rate. Each of these systems is undesirable from the standpoint of the Central Station: the flat rate, because of the absolute necessity of controlling the demand and hours of use, and its general inadequacy to meet conditions; the uniform kilowatt hour rate because of the necessity of the multiplicity of schedules necessary to cover all classes of service, and the impossibility of differentiating between the long and short hour consumer of the same class.

This paper was discussed by H. L. Wills, E. C. Deal, J. S. Bleecker, and C. E. White general manager of Montgomery Light and Water Co., Montgomery, Ala.

Mr. Wills emphasized the value of power data and the importance of considering diversity factor over a long period.

Mr. Deal read a written discussion in which he reviewed the early conditions in regard to commercial central station engineering and showed how facts and factors have made necessary the intelligent analysis of all conditions affecting rates and rate making. While he recognized the importance of diversity factor he also considered policy factor which he placed in importance over diversity factor. Mr. Bleecker held that all the elements of rate making should be carefully considered and voiced the opinion that conditions could be such as to make advisable one rate, referring to the dry goods store in the sale of its products in large and small quantities. Mr. White showed clearly that the net return from the small customer was not in proportion to that of the large customer. He did not believe in one rate referring to the workings of Wisconsin commission and others. He believed that a consideration of diversity factor most important to central stations today.

DISCUSSION ON SOUTHEASTERN SECTION.

At the close of this discussion, the meeting went into executive session when reports of various committees were read. At this time also a discussion took place relative to the formation of a Southeastern section of the N. E. L. A. and take in central stations in the States of Georgia, Florida, Alabama, North and South Carolina. Representatives from Florida, Alabama and South Carolina were present and an interesting discussion plainly indicated that all were in favor of the movement. The Florida representation was sufficient to act at once and their applications were made for admittance to the section. In the cases of Alabama, North and South Carolina, plans were laid whereby committees could make the necessary arrangements and comply with the requirements of the National body in the organization of such sections. Every indication points toward the completion of these arrangements in the near future.

ELECTION OF OFFICERS.

The report of the nominating committee read at this session proposed the following as officers for the coming year. The report was accepted and following officers elected. President, E. C. Deal, General Manager Augusta-Aiken Railway and Electric Corporation; Vice-President, T. W. Peters, Commercial Agent Columbus Railroad Company; Secretary-Treasurer, M. H. Hendee, Commercial Agent Augusta-Aiken Railway and Electric Corportion; Executive Committee, E. S. Roberts, Commercial Manager, Savannah Electric Co.; C. D. Flanigen, Vice-President Athens Railway and Electric Co., and W. L. Southwell, Commercial Engineer, Central Georgia Power Co., Macon, Ga.

Mr. Deal took the chair and with most fitting remarks accepted the honor.

Members and Guests Attending Convention at Tybee Hotel.

ENTERTAINMENT FEATURES.

With the exception of the afternoon of the first day of the convention and the evening of the second, all sessions were held in the morning and the afternoons and evenings left open for recreation. On the evening of the first day, a 16 mile ride on the Atlantic was enjoyed by members and guests. On the afternoon of Friday the trip to Fort Screven was postponed on account of rain. The time was well spent in bathing as an excellent beach afforded the best of surf bathing. During the evening of Friday the Sons of Jove held a rejuvenation and Joviation when 15 new members were initiated.

On Saturday afternoon an auto trip was taken through

Savannah which ended with a dinner at the Casino at Thunderbolt. This dinner was tendered the members and guests by the manufacturers, prominent among them being the General Electric Co., Westinghouse Electric and Mfg. Co., Electric Storage Battery Co., and Western Electric Co.

The New President.

The Georgia Section of the N. E. L. A. which will soon change its name to the Southeastern Section, has elected as its third president and the first to guide the work of expanding beyond the borders of one state to include five, a man who is fitted by more ways than one to not only carry on the good examples set for him, but further multiply these examples through action in a larger territory. First, he is of Southern birth and has a host of close friends in the central station business of the South. Second, he has been connected in various capacities in the gas, electric

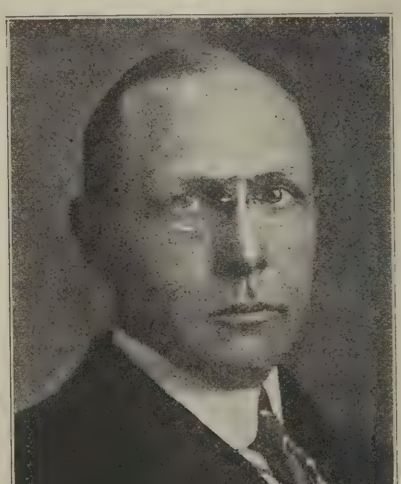
E. C. Deal, President Georgia Section N. E. L. A.

light, power and railway business in both large and small fields in the Eastern, Western and middle West sections of the United States, and therefore understands the problems which are met with and require attention in these fields. Third, he has been responsible for the entire management of several electric properties and made each of them pay. Considering his abilities along these three lines, we repeat, that our Southern section is fortunate to secure his services as president particularly at this new and bright beginning in the organization of Southern central station interests.

We refer to Mr. E. C. Deal, General Manager of the Augusta-Aiken Railway & Electric Corporation, of Augusta, Ga., who was born in Georgia, receiving his first experience with the Georgia Electric Light Co., of Atlanta in the early 90's. He then was connected in various capacities and in different sections of this country with public service properties under the management of Stone & Webster Syndicate of Boston. After leaving the employ of this organization in 1904 he was connected with W. N. Coler, of New York, in charge of Burgen County Gas & Electric Co., which controled more than 40 municipalities in the northern part of New Jersey. He then went with the Public Service Corporation of New Jersey at the time they took over the gas and electric company of Burgen County, having charge as superintendent of the Burgen Division and later the central division, this division including all towns in the central part of New Jersey operated by Public Service Corporation. From this position he resigned to become general manager of the properties controlled by the syndicate of W. N. Coler & Co., of New York in North Carolina. In 1911 he resigned this position to go with the J. G. White Co., Inc., of New York as general manager of Augusta Railway & Electric Co., and the Augusta-Aiken Ry. Co., which have since been merged the Augusta-Aiken Railway & Electric Corp., now controlling the electric light and railway properties in Augusta and the Augusta-Aiken interurban electric line as well as the new 24,000 Hp. hydro-electric property on the Savannah River known as the Georgia Carolina Power Co., now being developed. The properties above mentioned are owned by the banking house of Redmond & Co., of New York, and the enginering firm of J. G. White & Co., Inc., of New York. Since coming to Augusta the electrical properties there have been rehibilitated at an expense of about one million dollars, and the general policy of the organization changed and improved in such a way that its standing in Augusta and with its customers everywhere is exemplary.

Mr. Deal has been connected with the N. E. L. A. through membership and in other capacities for the past fourteen years. He is also a member of the American Street Railway Association serving at present at a member of the fare committee. He is also a member of the Gas Institute of America. Outside of business he has always taken a personal interest in the upbuilding of the community in which he lives as is evidenced by the fact that he is a member of the Commercial Clubs of Greeneboro, N. C. and Augusta Ga., member of the Merchants & Manufacturers Club of Greensboro. He is also a member of the Country Club of Greensboro, N. C., and the Country Club of Augusta, The Gun Club of Augusta, and the Elks of Augusta.

In 1901 he married Miss Carrie Wahl of Baltimore, while then connected with the Edison Electric Illuminating Company of Baltimore. He has one child, a boy ten years old.



W. Rawson Collier, Retiring President.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Commercial Department Organization and Methods

Having considered the general functions of the commercial department, we will now study the methods and organization which are best calculated to ensure success. Sales managers, solicitors, and others experienced in commercial work are requested to freely contribute the results of their experience.

The organization advisable for a commercial work will depend upon the size of the company and the possibility for expansion. A small company operating in a town of only two or three thousand usually cannot attempt to maintain a separate commercial department, or even to keep a man exclusively on commercial work, consequently in most places of this size there is no solicitation done whatever. In thriving towns of 5,000 and upwards there should be at least one commercial man employed, and he should have no trouble in keeping busy. While not necessarily a high-salaried man, he should be a good solicitor, and be given a title which will show his position in the organization and command respect among his customers.

In very large cities the commercial department becomes quite a complex organization, with district managers, power, sign and illuminating experts, and a multitude of bureaus. The figure given herewith shows the organization of the contract and inspection department of the New York Edison Co. For the purpose of this discussion, however, we will keep in mind a department of medium size, such as we might suppose to exist in a city of from 50,000 to 200,000, and consisting of a contract agent, stenographer, messenger, and from 3 to 12 solicitors.

The question of location for the department is of prime importance. In many cities the location of the general offices is not convenient to the public, and cannot be well moved. In this case, the commercial offices should be separately located in a good business district, and when this location is settled, arrangements should be made to take care of every need of the customer. Not only should applications for service be received, and appliances displayed and demonstrated, but money should be received on bills, and lamps renewed, to the end that every customer having dealings with the company may be brought under the influence of the sales department.

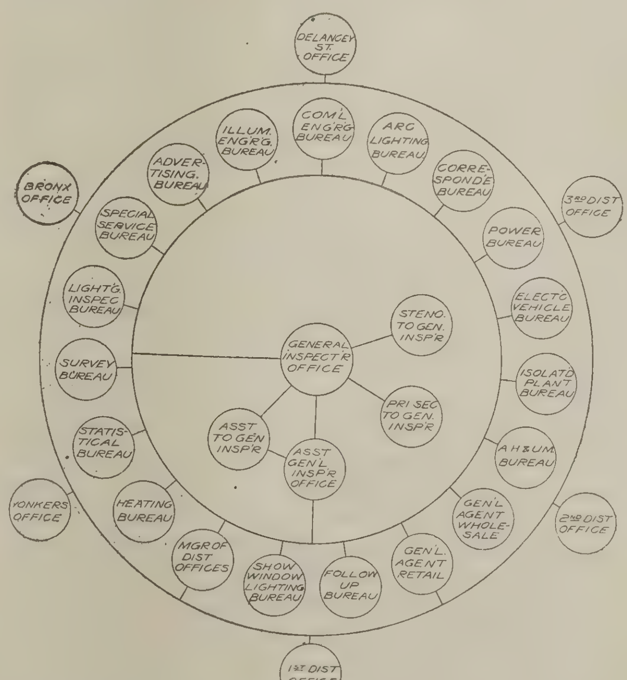
The sales manager is, of course, the central figure of the organization, and upon him depends the success or failure of the department. He should have had a well rounded experience, be active and energetic, yet conservative and careful, basing all his work on sound business principles. He should be a technical man, as this will give him a great advantage in dealing with many of his customers and also enable him to hold his own with operating department where questions of service are concerned. He should be a good judge of men, and it is perhaps superfluous to say that he should have a free hand in the selection and handling of his solicitors.

We are constantly reminded that order-takers are plentiful, but good solicitors are scarce. Such being the case, care should be taken to get good men and treat them so that they will be encouraged to remain and do their best.

The soliciting body should be an active, energetic, neat, courteous, and business-like set of men. While their demeanor towards customers should always be pleasant, they should not be selected for their qualifications as "good fellows" for the time is, or should be, for ever over when a hotel bar should be thought of as the most desirable place to close up a business deal. Such habits are sure to grow upon a man until he will in some unguarded moment do more to discount his company in public opinion than the little business which such practice may have brought in is worth.

After the solicitors are selected they should be assigned to certain given territories, and these assignments should not be changed, but the men encouraged to grow up with their district, knowing it thoroughly, even to the owner and tenants of every property. They cannot do this if put on too large a field where all their time will be taken in following up inquiries and adjusting petty complaints. They must have time to do some house to house work and to dig up some business. One man cannot well attend to more than a population of from 10,000 to 20,000 where there is much new building and changing.

Each man's territory should include some residences and some business houses, although the central portion of the city may well be given to one of the older and more experienced men. The business section requires close and frequent canvassing, and the solicitor should be a well-known figure on its streets. This he cannot be if he has



ORGANIZATION OF CONTRACT AND INSPECTION DEPARTMENT OF THE NEW YORK EDISON CO.

much residence work to lookafter. If the size of the force permits, there should be one man to specialize on power and another on signs, while with a small company these may have to be combined or be taken care of by the general commercial solicitor.

SALARY VS COMMISSION.

As to salary, the general method is to pay the solicitors a straight salary, basing the same on their value to the company. There are some who have adopted a combination salary and commission basis, but in order to make the commissions equitable, quite a complicated schedule has to be worked up, and this of course, means clerical expense. Besides this, a solicitors time is so often taken up with things which would be no direct benefit to him under a commission schedule that there would be a temptation to slight this part of the work.

In addition to the solicitors for electric service, there should be a good man on appliances. Some companies, even in large cities, make it a rule to hire transient solicitors for the summer to canvass for irons and such articles. The objections to this plan, as we see it, are principally this, that these men, not being permanent employees will not have the interest of the company at heart as they outherwise would, and being paid usually on commission will often make statements to make a sale, which later prove embarrasing to the regular force who have to follow up their work. Experience seems to indicate that it is better to have a permanent man on this work and pay him a salary plus a small commission on sales. In even a small city he can keep busy most of the year. Starting in the spring with electric irons and fans, etc, he can gather prospects for vacuum cleaners and washing machines as he goes along and work on them after the fan season is over. He can also attend to the renting of cleaners during the house-cleaning seasons.

METHODS OF WORK.

As to methods of work, it is our opinion that while special campaigns are often of great benefit, no amount of spasmodic effort can take the place of straight plugging away, day after day and making a thorough house to house canvass of the entire field. If a man is new to his field there is no better way to go to work than to take his section, street by street and house by house and get full information on every place. Customers should be called upon to escertain if they are satisfied with the service, and to talk up extensions and new uses for current. The results of every call should be carefully reported on the daily report sheets, to be tabulated by the office force, and the work of the solicitor thereby conserved. If the solicitor will make out a small slip for each prospective user of current and file it away in his own "tickler box" under the date that such person should be seen again, he will find that in a short time he will be kept quite busy in looking them up, and that as his acquaintance with the territory grows so will his business. If he keeps faithfully in touch with his prospects he will be gathering them for months to come. In the meanwhile he can go along with his street work as opportunity offers, and if his territory is properly apportioned he will get entirely around it more often. In this way the solicitor becomes acquainted with the wants of each customer and prospect, nips many a grievance in the bud, clears up errors of records and takes notes of removals, new buildings, etc.

In starting a new solicitor out in a territory which has been worked before the same rules will apply, except that the new man should have the advantage of prior information. This can be done in the following way. The contract agent may select some street or streets and have the stenographer make a list by house number of each house or place of business, the name of the person occupying it as known to date, business, and very brief note indicating result of previous calls. This takes a good deal of time, but it enables the new man to get right down to earnest work and also avoids the possibility of active prospects being lost through the unavoidable changing of solicitors. Every year or two each street should be given an "overhauling" and the records brought up to date.

It is assumed that the sales office is promptly advised of all connections made or parties disconnected. Solicitors should have due credit for everything coming in from their territory whether they secured it personally or not, always providing that their general activity entitles them to such credit. They should also follow up every disconnection; ascertaining cause and get what business there is to get at that location. Each month, every solicitor should be furnished with a list of all locations in his territory which have not been re-connected and should be required to report on each one. If not cleared up these should be put again on the next months list and this continued until the location is either occupied and connected, or service positively and finally refused, or some other reason secured why no business can be obtained. Inquiries coming in by mail or Phone should be written on a small slip with carbon copy and given to the solicitor for report, the copy being put ahead two or three days in the contract agent's box to avoid its being overlooked.

At least once a week, (some sales managers do it daily) the men should be called together for a few moments at the beginning of the day's work to talk overbusiness conditions. The contract agent should also seek opportunity to frequently go over each man's work with him, not in the spirit of an inquisitor, but with a sincere desire to help him over any hard places that he may have encountered.

RECORDS OF COMMERCIAL DEPARTMENT.

The records of a commercial department should be simple and adequate. It is very easy to tie up the department with so much system as to seriously hamper its operation, but at the same time a certain amount of system is necessary. A system of reports is necessary. Besides the daily report which should be accurately and promptly turned in by each man, it is well to have a monthly report showing the calls each day and the business secured. It will also be necessary for the contract agent to make up a monthly analysis of the connections and disconnections and report to the general manager with a statement of what it has cost to get the business.

Besides these reports, we may say that there are two classes of records needed. First there are those in which events are set down in the order of their occurrence, and there are those in which the information is arranged alphabetically or according to location. The first are best kept in a loose leaf book, and the second class on cards. In the first class comes the record of contracts, of disconnections, of appliance sales, of stock received, of articles loaned on trial, and of cash handled. In a small office, a loose leaf ledger can be bought with blank sheets and a few of each kind of ruling made by hand as needed. Under the second heading would come the index of customers arranged by

street and number, with the principal facts which are needed to be known. A 4 x 6 card will usually suffice for this. There should also be arranged by street and number, a card for every prospect, giving the principal data of value with reference to the result of calls which have been made. This can be kept on a 3 x 5 card. It is also well to have an alphabetical index, at least of all customers with whom special dealings of any kind have been had. By means of these indices not only can one keep track of a location, and see who has occupied it from time to time, but can follow the customer as he moves from place to place. It will also be found convenient to keep a card index of black listed persons to be referred to as each contract comes in.

SALES STANDARDIZATION.

Finally a few words as to sales standardization. No business can do its best run on a hit or miss principle. Yet it appears that the majority of commercial departments are run just that way. There is but little attempt at standardization. Too much is left to the individual judgment, and we find that even in important matters that the company has no well defined policy. Not that we would crush individual judgment, but that we would assist it by formulating certain general policies which shall always be followed except for good cause. For instance we should have a published rate, put in such terms as to be easily understood. There should be well defined regulations regarding extensions, service connections, meter locations, sign regulations, motor requirements, temporary service, vacation disconnections, terms and loans on appliances, in fact nearly everything which a customer would be likely to ask. If these things are printed in a neat booklet and distributed by the solicitors to persons who are interested they will serve a valuable purpose in education, along the lines of public service relations.

Furthermore the solicitor should be furnished with definite written instructions regarding all points where uniformity is necessary or desirable. He can then not plead ignorance in case of a mistake. However no solicitor should fall back arbitrarily upon a ruling of the company but he should know the reason for the rule existing, and be able to convince the inquirer where possible, that it is a reasonable regulation.

In conclusion we will consider what should be expected from a commercial department. How can we distinguish natural from cultivated growth? The natural growth in business will be a little better than the growth in population. Not only does a town grow in size, but it grows in education. Houses being erected are much more apt to be wired than those already erected were at that time. If the increase in population in a town should be 5 per cent during a given time, we might consider a natural growth for electric service during the same period to be 8 or 10 per cent and credit all above that to sales effort. As to the estimated cost of new business, it is usually figured as so much per Kw. connected load. It is not the Kw. of new business that should be taken as a basis, but the Kw. of net increase in connected load. While special campaigns may show apparently very low figures for expense per Kw. of new business, in the long run the cost of increasing the connected load will run from $5.00 to $10.00 per Kw. and occasionally higher.

As far as there appears to be any practice, it seems to be considered wise to set aside from 2 per cent to 5 per cent of the gross revenue for the purpose of securing new business. Another and a better plan is to figure the commercial expense on the basis of percentage of the increase in annual gross revenue, allowing from 25 per cent to 75 per cent of the increase to go for this purpose. This is the same as saying that it costs from 1/4 to 3/4 of the first years business to get it.

There are a number of other points yet to be touched upon which we hope to have discussed at some future date.

A. G. RAKESTRAW.

Commercial Results Classified.

BY R. B. MATEER CONSULTING ELECTRICAL ENGINEER, DENVER GAS AND ELECTRIC CO., DENVER, COLO.

Granting that each central station should have a commercial or busines developing department under the control of an executive officer, and that such an organization should not be burdened with so much routine work as results from the keeping of many records of doubtful value and which in a way retards the proper growth and development of the organization, it frequently happens that the methods of attaining results are not considered but the results themselves viewed from a profitable standpoint. So far as the revenue in relation to the expense incurred to connect such business, the methods are of far more importance and worthy of much consideration.

Some companies prefer to go after new business, or that which occasions investment expense by reason of transformers, meters, loops, and clerical expense of opening new accounts. Business of this character is sometimes considered of greater value by reason of an additional consumer connected to the line or main, depending on whether the company is an electric, gas, or combination organization. In justifying expense occasioned by this character of business, much stress is given to the additional business possible in the ensuing years, and occasioning increased consumption, thereby neglecting entirely the additional business which may be secured by an intensive educational campaign among present consumers. In classifying therefore, central station business, why not consider it from an investment standpoint, determining the profitableness on the basis of expense incurred for connection. Therefore, cannot additional business derived from present consumers be considered the most valuable to any company?

Granting that additional business from present consumers is worthy of development expense by reason of little or no construction charge, why not give second place to that business which may be retained merely by diplomacy in satisfying the customer that the charges are just and reasonable. Too many companies give entirely too little attention to the kicker who seeks to know the why and the wherefore of his bill, and who at large with no explanation becomes a dangerous and unsatisfied personage, always seeking to further statements detrimental to the central station, its growth and welfare. Some care in investigating a complaint and its reasonableness, combined with courtesy, results in a friend gained. Business is continued with the same customer, thereby entailing no shut-off or collection expense. Is not the holding on our line, a customer who considered himself abused and who may become a staunch friend, also a live prospect for additional consumption by reason of additional appliances, of more importance than locating the consumer who can give you only new business?

Admitting the above mentioned classes of business, the

third worthy of consideration, is new business secured by reason of connecting to our lines one who at no time patronized the central station and who by personal calls from the representative, eager to please, now becomes a source of revenue by reason of the investment in line. measuring devices and capacity. In fact, business of this character might be termed as more or less unprofitable the first year by reason of the investment on the part of the central station. Therefore, do not the results of commercial development so far as profits are concerned, depend primarily upon the initiative in developing that class of business which occasions the least investment expense to the central station?

More About Rates.

In the August number several spirited contributions were presented on the rate question, two of which were in the line of a criticism of the material published in the July number. We were glad to note that these contributors looked more at the commercial side of the question, as it is this view point that we particularly desired and considered. We were also glad to note that each one seemed to have the courage of his convictions, and that while there were differences in opinion, the whole discussion was sane and sensible. It is impracticable, and indeed we would not wish to go over every little point wherein differences of opinion have appeared, but to call attention to one or two things. First, we did not intend to give the impression in the July editorial, that the Doherty rate is not a good business getter. In fact a perusal of the editorial will show that we assigned it a prominent place in our recommendations. Our intention was to convey the thought that it alone, could not appeal to all classes of business. The points brought out by Mr..Mendenhall are very well taken. Mr Mateer also presents decidedly forceful arguments in regard to keeping the rate question as far as possible on a sound commercial basis.

Mr. Neale, of England points out the tendency in that country to "contract" tariffs using current limiters, or as we would say a controlled flat rate with the excess indicator. In our opinion it is not wise for commercial managers to deliberately shut their eyes, as a great many are doing, to the business among small residences to be gained by the use of this device. Every central station has in its territory a large number of small houses which are not wired, owned by the people living in them. The combination of a liberal wiring proposition with the controlled flat rate will do much to bring them on the lines. It is thought by many that the introduction of this rate will cause a loss of revenue and dissatisfaction among the present meter customers. It is true that a few will want to change over, but the great majority, especially those who have other uses for the current than light, will be satisfied to keep their meters.

Altho we have pretty well covered the rate question from a commercial stand-point, we will welcome the experience of any central station commercial manager who has had experience with this device as a business getter.

Mr. G. S. Merrill, Assistant Chief Engineer of National Electric Lamp Association, Cleveland, Ohio, on the Subject of Rates and Rate Making.

The writer was interested to note the difference of opinion expressed in the rate articles by Mr. Rakestraw and by Mr. Wood, which appeared in the New Business Department of Southern Electrician for July. This difference of opinion is typical of the greatest difference of opinion on the subject of rate making that exists today throughout the industry as a whole. For the large customers both writers favor the use of differential or "scientific" rates and in this respect they agree with the majority of those who have studied the subject, theoretically and commercially. For the small customer Mr. Wood favors a differential rate of the Hopkinson type (that is with seperate demand and energy charges) whereas Mr. Rakestraw holds that the introduction of fixed charges in rates for residences and small stores has a tendency to kill this class of business unless made optional. Whether the small customer should be served on a differential rate taking into consideration the hours use of service or whether he should be given a straight line meter rate seems to be the great problem in rate making today.

A careful analysis of the rates here and abroad, together with a study of the tendencies exhibited in the changes being made from time to time indicates very plainly that the advocates of differential rates for the small customers are steadily, and now even rapidly, gaining ground. The change in the character of electric service in the home brought about by the development of heating and cooking devices and by the increase in efficiency and decrease in wattage of incandescent lamps has served to make the use of differential rates more and more commercially necessary. Forms of differential rates have now been developed which are almost as simple as the old straight line meter rates and with the many recognized advantages of a differential rate under the new conditions existing in the industry their adoption will surely be more rapid from now on.

Those who recognize the great possibilities of developing uses of electric service in the home for other than lighting service are generally in favor of a differential rate which will develop this business most rapidly. Where the possibilities of such service are not as yet particularly evident because a community is backward in its electrical development, the old straight line meter rate is regarded as good enough. Some of the Wisconsin Companies, who were obliged by Commission ruling to establish differential rates for residential service in place of straight line rates, found that their business showed a most pleasant tendency to expand along profitable lines in spite of their apprehensions regarding the scientific rates and in spite of their previous certainty that the straight meter rate was just what they needed in their particular case.

Of the several differential forms of rates, Mr. Wood favors the Hopkinson system as being most logical. Theoretically the Doherty system which recognizes the customer charge in addition to the demand and energy charges recognized by the Hopkinson rate represents the cost of service more correctly than a rate covering demand and energy only. The classification of customers into general groups as large, small and very small makes it possible to include to some extent the average customer charge for each group in the demand and energy charges, and while this may not be theoretically correct, it is commercially justified when we consider the small consumer's distaste for anything in the nature of a fixed charge. In the case of the large customers a rate made on a Hopkinson basis, with fixed and running charges covered separately on a block system can be made to automatically include a customer charge

and to meet the requirements of the Doherty theory although maintaining the simple Hopkinson form.

It would be well, is possible, to use the Hopkinson rate for both large and small consumers, but the small consumers' well recognized dislike for "fixed charges" of any kind which was commented so strongly upon by Mr. Rakestraw would seem to indicate that the Hopkinson rate, with a fixed demand charge would be unpopular for such service in this country. A multiple rate making a high primary kilowatt hour rate for all energy used up to a certain amount each month depending upon the size of the installation, and a low secondary kilowatt hour rate for all energy used in excess of this amount, would meet with more general favor. The Hopkinson form of rate has been used with success for small business in Canada, England and on the continent but it seems to have met with little favor here, although it is a very good form of rate and one that is simple in its applications.

In a differential residential rate, the general use of electrical demand measurements at present as Mr. Wood suggests, would I believe seriously affect the free installation of electrical heating, cooking, refrigeration and other devices. Such devices because of their day use and high diversity factor can be profitably carried at the secondary rate without increasing the primary requirements. For the time being a differential rate establishing the fixed charges or use of current at primary rate according to the extent and value of lighting service only, as indicated by the number of rooms or floor area illuminated, would be more equitable than one using as a basis the measured electrical demand. The writer believes that the rate for the small customer, which would be most generally satisfactory for present use and safest in view of future developments, would be a multiple rate, based primarily upon measured or controlled electrical demand, *with the important provision that for lighting installations the demand will ordinarily be figured on the basis of area or number of rooms illuminated.*

Multiple rates based on floor area or number of rooms have been used successfully by several of the larger and more progressive companies in this country. Their equitable distribution of fixed charges in relation to both the cost and value of lighting service, their encouragement of "off peak" use of current at the low secondary rate and the simple form in which it is possible to express them by the use of terms familiar to the ordinary consumer makes them the most promising form of rate for residential service that has yet been developed.

Fire Protection in Power Plants.

At a meeting of the Birmingham Association of Electrical Engineers on August 12, Mr. W. L. Upton, a consulting engineer and member of the association at Birmingham, Ala., read a very interesting paper on the above subpect. Mr. Upton emphasized the wastes resulting from fire loss, stating that good engineering provides against a double loss by fire in applying electrical energy to mechanical processes, namely the direct loss of material and that of interrupted production. Continuing with his subject the author gave vital suggestions in regard to design of switchboards and the handling of circuits of 550 volts and over. In this regard he has the following to say:

"In handling A. C. circuits it is best not to bring any potential above 550 to the face of the board. In the case of moderate voltages where the oil switches are mounted directly on the panels the primary wiring should be kept at an absolute minimum and all auxiliary devices which carry primary current such as instrument transformers should be mounted entirely clear of the board. Secondary wiring for instruments etc., should be as simple as possible, thoroughly grounded, and should be provided with test clips so that any instrument or device may be tested without "skinning" any insulation or moving any wiring.

"When handling circuits above 3,000 volts it is well to mount the oil switches entirely away from the panel. Either very liberal space should be allowed around such switches or they should be mounted in cell construction. The latter should be done in all cases of over 13,000 volts. In large capacities this should be done at much lower voltages. Bus construction should receive careful consideration with two features especially in mind. First, safety from falling bodies, which can be provided against by choice of location or by a protective structure of cement or brick, and second accessability to all connections. Any slight difficulty will usually be neglected until something serious happens unless it can be reached quickly and safely.

"All primary wiring should be on standard insulators attached to metal or concrete supports. Portland cement mortar is the best finish for the entire interior, except in those cases where finances will permit ornamental tile, as on expanded lathe it makes a light structure and has good fire resisting qualities. The larger the number of low and medium voltage circuits that can be run in conduit the better. It must be remembered that interior conduit is not primarily to protect the circuit, but rather the building and every detail of construction should be laid out with this fact in mind. This is what makes the thorough grounding of conduit so important.

"Large transformers should preferably be in a separate structure but where this is not advisable a separte room should be walled off for them and carefully fireproofed. It is well to permanently pipe the cases to drain by gravity to a receiving tank so that in case oil gets on fire the larger portion can be drawn off. A thermometer in the line will indicate when the burning oil is so low in the transformer tank as to be dangerous to the receiving tank. When this point is reached the valves can be closed and the balance of the oil allowed to burn. This drain will remove a very large portion of the possible fuel and thereby limit the fire. Prompt action in draining a burning tank will often save other units and prevent interruption to service.

"The chief points emphasized to prevent fire are; space, simplicity in wiring, full insulation either by selection of location or on the conductor, the installation of all devices which could start an arc or furnish fuel to the fire in fireproof compartments, and cleanliness. All but the last point are inherent in the design or construction, and for these the Engineer is largely responsible. The last introduces the personal element which is possibly the most difficult to control, but is not the less important. The operating organization must take the burden of this feature but the engineer should do all in his power to so design the plant as to encourage the operators to continued efforts in this feature of their work."

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

BANKING TRANSFORMERS.

Editor Southern Electrician:

(317.) I would like to know if it is not advisable or at least as satisfactory to bank all transformers of the same capacity on a small system say 75 Kw. 3-phase. Also is it practicable to bank transformers of different sizes?

J. H. McMILAN.

[NOTE: In answering this question, readers are requested to note the comments on page 171 of the October 1911 issue and page 213 of the November 1911 issue, on loading of transformers. The answers should not duplicate this discussion.—Editor.]

GENERATING VOLTAGE.

Editor Southern Electrician:

(318). We have three water powers of the following capacities: No. 1 is about 3,000 Hp., No. 2 about 4,500 Hp., and No. 3 about 6,000 Hp. Mills are located at Nos. 2 and 3 only. Development No. 2 is three miles down the river from No. 1 and it is about two miles from No. 2 to No. 3. What would be considered the most practical generating voltage at development No. 1 to transmit current to both mills No. 2 and No. 3. A steam auxiliary will be constructed at No. 2 and the working voltage at motors is 440. Suggest selection of generator sizes for ordinary mill work and also transformer arrangements and connections.

J. F. CARRIGAN.

NATURAL FREQUENCY OF TRANSMISSION LINE.

Editor Southern Electrician:

(319.) What is meant by the natural frequency of a transmission line and what relation does it have to the actual frequency?

H. F. M.

CHANGE OF SERIES ARC SYSTEM TO INCANDESCENT SYSTEM.

Editor Southern Electrician:

(320.) Certain members of our electric light committee are dissatisfied with the operation of our series arc system and a change to series incandescents has been proposed. The arc lamps used are 6.6 ampere enclosed. Can series incandescent lamps be installed and use the same constant current transformer we are now using without a special regulator? How much saving could be effected by removing 50 arc lamps and securing equal illumination by incandescents?

R. W. T.

WHY CAPACITY OF 6-PHASE ROTARY GREATER THAN 3-PHASE?

Editor Southern Electrician:

(321.) I would like to have some reader explain why a 6-phase rotary converter has a greater capacity than a similar 3-phase machine. Why is this type machine not built in the smaller sizes? Also what arrangement of transformer connections is considered best for this machine and why? Give diagram.

F. E. B.

DESIGN OF STEEL TRANSMISSION TOWERS.

Editor Southern Electrician:

(322.) There seems to be a variety of designs of transmission towers used by the high tension hydro-electric companies. What are the advantages claimed for the two and three-legged types, a combination of two three-legged towers for a double circuit, and the four-legged tower of wind mill type, for double circuit? What are the factors that determine the arrangement of conductors whether in a vertical plane or equilateral triangle?

W. C. T.

Transformer Core Losses, Ans. Ques. No. 258.

Editor Southern Electrician:

In looking over Mr. Hendricks' interesting discussion of question 258 in the April issue, I note a slight error in expression that might perhaps cause confusion. He says "it is seen that Ph varies directly as the frequency," which should read, "varies inversely as the six-tenth power of the frequency," in order to be consistent with the given equations. It is true that if the flux B is held constant Ph will vary as the frequency, being given by the equation 1 of Mr. Hendrick's article, but in that case the voltage would also necessarily vary with the frequency.

Voltage at Center of Distribution, Ans. Ques. No. 265.

The following correction should be added to my discussion of question No. 265 in the August issue: Equation 4 should have been written in a simpler form, which is $El_1 = \sqrt{[E_1^2 + E_2^2 + 2E_1E_2 \cos D_1]}$. In the phrase immediately following equation 5 the word "of" should be "if."

Watt-Hour Output of Storage Batteries, Ans. Ques. No. 316.

If a storage cell is discharged at a high rate the outer portions of the active material will be reduced (peroxide to sulphate, etc.) before the inner parts can be reached by the acid and since the voltage of the cell is determined chiefly by the condition of the outer parts of the plate it will be as low as can be permitted while the inner parts are still charged. Also any further discharge of the outer layers of material would damage the plate. It is the non-use of the inner parts of the plate that causes the reduced capacity.

There may be leakage of charge also due to local action, impurities (iron, etc.) in the electrolyte which will cause the capacity to be less than normal. As this leakage discharge takes place all the time its effect is more noticeable if the battery be discharged at a very low rate.

T. G. SEIDELL.

A Discussion of A. C. Wiring, Ans. Ques. No. 281.

Editor Southern Electrician:

The National Electric Code requires that leads or branch circuits to motors must be of such capacity as to carry a current at least 25 per cent greater than that for which the motor is rated. This is generally satisfactory in

service for the direct current motors. Leads of this extra capacity can be fused with fuses not greater than their rated capacity and at the same time allow for the extra starting current. This is not sufficient, however, for alternating current motors, especially of the squirrel cage type. In the Table I. of carrying capacities of wires, one column is given for rubber covered wire and one for wire with insulation other than rubber. Rubber-covered wire is allowed a somewhat smaller capacity because of possible deterioration or drying of rubber insulation with age and heat. Where rubbercovered wire is used the code ruling allows the starting fuses for squirrel cage motors (or others requiring large starting currents) to be selected according to the allowable current carrying capacity of wires having other than rubber-insulation see column 3, of the table.

TABLE OF ALLOWABLE CARRYING CAPACITIES.

Cir. Mils.	B & S Gauge	Amps. R. C.	Amps. other Insul.	Dist. in ft. for a loss of 2 Volts.
1624	18	3	5	
2583	16	6	8	
4107	14	12	16	31
6530	12	17	23	36
10380	10	24	32	40
16510	8	33	46	47
26250	6	46	65	53
33100	5	54	77	57
41740	4	65	92	60
52630	3	76	110	64
66370	2	90	131	68
83690	1	107	156	73
105500	0	127	185	77
133100	00	150	220	82
167800	000	177	262	88
211600	0000	210	312	94
200000		200	300	93
250000		240	350	97
300000		270	400	102
350000		300	450	108
400000		330	500	112
450000		360	545	116
500000		390	590	120

Starting of a squirrel cage induction motor is accomplished by an excessive rush of current varying between four and nine times the normal full load running current, according to the load on the motor. This type of motor should be started under light load and a starting compensator, or a resistance type starting rheostat or star-delta switch (for small sizes) be used to cut down the starting current. As the horsepower developed by an induction motor varies with the square of the voltage, they should be supplied with current at the voltage for which they are designed. Conductors should be large enough so that excessive voltage drop does not occur. This is usually provided for normal running condition, but frequently the drop during starting (when the current is large) is excessive. This is just the time when the full voltage is all the more necessary to provide for the starting torque. Various more or less complicated formulas and rules have been suggested for the calculation of wire sizes for alternating current motors, but if heavy enough leads are provided to take care of the starting current and to allow for proper fusing, ample provision will have been made and no extra calculations or formulas need be considered, for the ordinary installations of alternating current motors.

In transmitting alternating current, the central core of a wire carries less current than the area near the outer surface. This effect on systems of high frequency and where large conductors are used, results in the outer area carrying most of the current and the interior or central core is not much value. This is the same as reducing the cross-sectional area of the wire carrying alternating current and this means a little additional resistance. On systems of frequencies above 60 and with conductors larger than No. 4-0 B. & S. gauge this factor called skin effect must be considered. The resistance due to skin effect therefore increases with the size of the wire and with the frequency of the system. Conductors, as used most extensively in industrial plants for wiring to motors are usually smaller than solid No. 4-0 or are made up as stranded conductors of smaller wire and the skin effect is inappreciable.

The problem of providing conductors of suitable capacity for carrying the starting as well as the running current to insure against excessive drops in voltage, to allow for fusing to give ample protection to motor and leads and to comply with engineering and Underwriters requirements, resolves itself into a really simple one.

The squirrel cage motor because of its great current demand at starting is the cause of most fuse trouble on alternating current systems and this will be considered first. The torque at starting, efficiency, performance, etc., of the squirrel cage motor depend upon the design of the rotor. Before installing, the character of service for which the motor is to be used should be considered and the facts given the motor manufacturer before buying. For steady all day use a motor having a rotor of relatively low resistance is best suited, while if the motor is required only for short periods and more than the average starting torque of squirrel cage motors required, a high resistance rotor may be better.

Motors of small capacities, 1, 2, 3 and 4 Hp. are frequently connected to the line by means of a double throw knife switch with fuses arranged as shown in Fig. 1. These motors are usually tapped off of some larger mains which makes this arrangement usually satisfactory. The set of starting fuses is somewhat larger than where a starting rheostat or compensator is used. There is also a larger current inrush but as this is small for small motors in proportion to the main motor load it is not always objectionable. But for larger motors, compensators, resistance starting rheostats and star-delta switches are used for reducing the starting current.

A compensator impresses a lower voltage on the motor stator winding at starting so that the heavy starting cur-

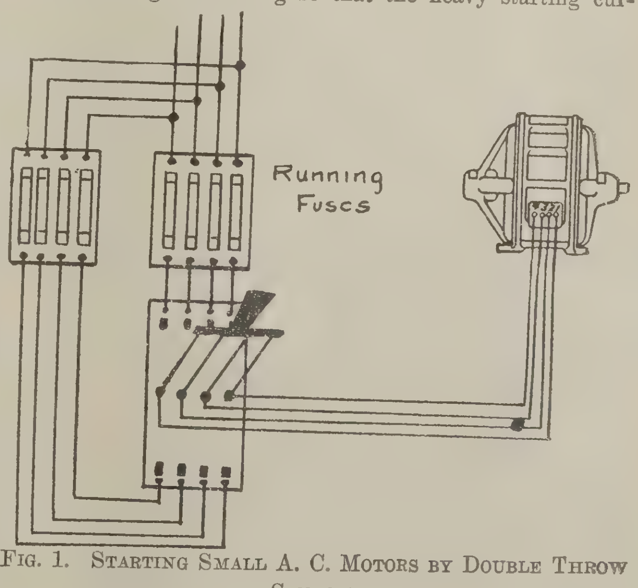


FIG. 1. STARTING SMALL A. C. MOTORS BY DOUBLE THROW SWITCH.

rent is reduced. But as the torque of the motor depends upon the voltage supplied to the stator winding, decreasing the voltage also decreases the torque and this is one reason for the necessity of starting squirrel cage motors of the general design under light load. To get full starting torque the full rated voltage is required at start and this causes the undesirable heavy current inrush.

The taps ordinarily provided for compensators up to 20 Hp. give 50, 65 and 80 per cent of the line voltage and under given conditions the respective currents taken by the motor, starting, will be 25, 42 and 65 per cent(respectively), of the current that would be taken if the motor were thrown across the line without starting device. The second tap giving 65 per cent line voltage is usually connected in the case of a motor requiring running current of 10 amperes per phase and 90 amperes on starting without compensator, the 65 per cent tap would cut this to 42 per cent of 90 amperes or about 38 amperes. For large motors four taps are provided giving 40, 58, 70 and 85 per cent line voltage.

Star-delta type starting switches are used to some extent with small three-phase squirrel cage motors (up to 550 volts) that have their stator windings so arranged that the starting position of the switch connects them in star and the running position connects them in delta. Two sections of the winding are connected in series across each phase, when starting and the voltage of each is reduced to 58 per cent of full line voltage. The voltage at starting in each phase is 128 instead of 220 volts, which reduces the current to about 35 per cent of what it would be if no starting device were employed. In the running position each phase of the stator winding received the full line voltage.

Resistance starters similar in appearance to starting rheostats used with direct current motors are serviceable with squirrel cage motors up to 20 to 25 Hp. The first step of starting handle cuts voltage to the stator to 45 or 50 per cent of full line voltage and passing to successive steps increased this to 60, 70, 80 per cent, etc. Because the means of starting a squirrel cage motor has a bearing on the installation, fusing, etc., the above relating to the devices is given.

For all practicable purposes the leads for the squirrel cage motor used in the factory or industrial plant should be 100 per cent greater than the rated full load in amperes when starting under no load. If the motor is required to start under a slight load, leads having carrying capacities 150 per cent greater than the full load current of the motor should be provided. This will not only allow the proper fuse protection (referred to below) but provides for all ordinary lengths of runs, for power factors as usually found, and for supplying the current without excessive drop in voltage, during starting or running.

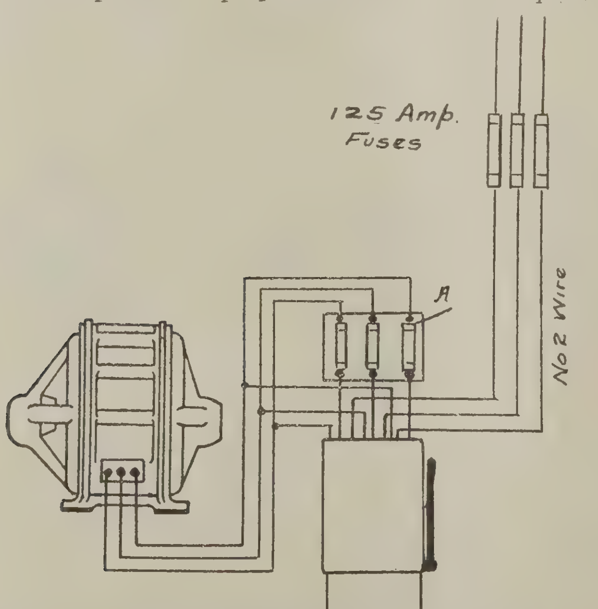


FIG. 2. STARTING MOTOR BY USE OF COMPENSATOR.

FULL LOAD AMPERES—THREE PHASE MOTORS.

H. P.	220 Volts	440 Volts
1	3.	1.5
2	6.	3.
3	9.	4.5
4	11.	5.5
5	14.	7.0
7½	20.	10.0
10	27.	14.0
15	40.	20.
20	50.	25.
25	63.	32.
30	75.	38.
35	89.	45.
40	100.	50.
50	125.	63.
75	185.	93.
100	250.	125.

Example: Consider a three-phase 15 Hp., 220 volt squirrel cage motor to start on light load, full load amperes 40, started by a compensator which operating on the 65 per cent tap cuts the starting current to about 130 amperes. Wiring to be run open on knobs or in conduit and rubber covered wire used. What size wires and fuses are required to comply with National Electrical Code requirements?

The table of allowable carrying capacities shows that a No. 2 rubber-covered wire carries 90 amperes which is nearest to 100 per cent greater than the full load current (40 amperes). In column 3, of table I, it will be noted that 131 amperes is given as the capacity for weatherproof No. 2 wire. For the protection of the entire run, 125 ampere fuses could be used and 50 ampere fuses for the leads from the compensator to the motor connectors so as to be in circuit only when the compensator lever is in the "on" position. The choice of 125 ampere fuse is in accordance with the Code ruling and the fuses would take care of the 130 ampere starting current without blowing as a fuse can stand about 10 per cent more than its rated capacity. Fuses for rubber-covered leads for induction motors may be selected using the weatherproof insulated wire rating (Column 3). Figure 2 illustrates the example just given. As the compensator switch disconnects all line leads when in "off" position, a separate main line knife switch is not essential although often used.

Running fuses should be provided to prevent a burning out of the motor due to a prolonged excessive overload during operation which may result from many causes. These fuses for this reason should be but slightly greater than the full load ampere rating. This is also necessary to give protection against a polyphase motor running on one phase.

It often occurs that one of the running fuses blows which allows current to flow in one phase. The motor will run, but the one phase will be overloaded to carry the load. More than normal current is required and if the fuses are too large this will in time mean overheating or burning out of the phase winding. Fuses of proper capacity will blow when this condition exists and call attention to the

fact that the motor was operating single phase instead of as desired, a polyphase.

A squirrel cage induction motor when driving heavy machines as hoists, elevators, punches, shearing machines, slotters, etc. may be installed in locations where fuse protection is of secondary importance. But here also the leads should be of liberal capacity as the large current demanded to produce sufficient starting torque will cause a voltage drop, in the conductors, which will in turn decrease the torque. This is especially true if the motor is located some distance from the source, as is often the case in large industrial plants. If the current is furnished by an isolated plant, excessive demands will be made on the generator requiring extra capacity, while if supplied by a central station power company, line disturbances and regulation troubles will result.

The torque of a squirrel cage motor varies as the square of the voltage impressed on the stator winding so that if the starting current is large, the conductors should be of sufficient capacity so that the voltage drop will be small. So aside from the electrical inspector's ruling in regard to having the motor leads of sufficient capacity to allow proper fusing, there are still better reasons why this requirement should be observed. Too many times apparatus, motors, etc., give a poor performance because of the lack of forethought in laying out the wiring.

In Fig. 2. fuses marked A, are not in circuit when the compensator handles is in the starting position but only when the handle is in the running position. In the example cited these fuses would be about 50 amperes capacity. The full load current for a three-phase motor $=$ (H. P. $\times$ 746) / (voltage $\times$ P. F. $\times$ Eff. $\times$ $\sqrt{3}$). Full load current for two-phase, 4 wire motor $=$ (H. P. $\times$ 746)/(voltage $\times$ P. F. $\times$ Eff. $\times$ 2).

Answer to Second Portion of Ques. 281, on Entrance of Wires.

That portion of the service wires (whether run as open wiring or in conduit) between the main fuses and switch on the interior of building to the bracket insulators outside of the building, must be rubber covered. Fuses or circuit-breakers, usually the former, and main switch in this case, must be placed on all service before meter in the nearest accessible place. The rated capacity of the fuses must not exceed the allowable carrying capacity of the wires as given in table. Opening of main switch must open every line, that is, be two-pole for two-wire service and three-pole for three-wire circuits.

G. J. Kirchgasser.

Discussion on Bastian Meters. Ans. Ques. No. 303.

Editor Southern Electrician:

I notice two answers to my question No. 303 in the August issue of Southern Electrician. One of them from a writer in England who thinks very favorably of the Bastian meters in question. The other writer, Mr. C. A. Vann, does not speak very favorably of the Bastian. He states that he is using about 75 meters of that make and that they are far from satisfactory.

I would like to hear further from Mr. Vann about these meters. I am inclined to believe he is mistaken about somethings he has said about them. For instance, he says they will register many times as much as they should. I would like for him to explain how that is possible. We know that the action of this meter is in accordance with the fact that an electric current flowing through water will decompose the water and of course the decomposition of the water is in proportion to the amount of electricity that flows through it and the length of time it flows through it. Now how on earth can this meter register wrong when there is no current flowing through it to decompose the water and what else is there to decompose the water but the electric current?

I may be wrong—there is a possibility—but I believe I am right and will believe it until some one proves to me that I am wrong. Then, the company that makes these meters guarantee them to be reliable and accurate and they will replace any part that proves defective within 3 years.

Has Mr. Vann been using or trying to use these meters on alternating current? They are only made for direct current.

I wish to thank Mr. Vann for his answer and would be glad to discuss the matter with him or anybody else. I am a new man in the business and have had no experience with meters but the "Bastian Recording Watt Meter" seems so simple and easy to handle that I like it, and if it does what the manufacturers claim, I think it a fine meter where not much current is used. We have one here in a moving picture theatre and we are working 25 or 30 lights and 3 fans through this meter. They are all working fine and the meter seems to be working fine so far as we can see. The electrolyte is as clear as the day we put it in. The last reading was 150 Kwh. Again I wish to thank Mr. Vann for his reply to my question, and let us hear from him further.

Robert B. Stone.

Grounding Secondaries, Ans. Ques. No. 307.

Editor Southern Electrician:

In answer to question 307 by G. S. R., in the July issue, the experience of the majority of companies with grounded secondaries has been that this practice is not only a protection to life but a protection to property and all electrical apparatus connected therewith. When the grounding of secondaries was first advocated many companies expressed a fear that it would increase the number of breakdowns in transformers, meters, etc., but at this date this fear seems to have vanished. In fact, breakdowns of apparatus has decreased after grounding secondaries. Another factor in favor of the grounding of secondaries is the legal advantage in cases of litigation. This advantage alone is a powerful argument for its universal adoption by all distribution companies. The Underwriters have made grounding of secondaries compulsory because it very materially decreases the fire hazard.

In the grounding of secondaries it must be borne in mind that, if any benefit is to be derived from grounding, the ground connection must be thorough. Grounds to water or gas mains are probably the most efficient.

J. J. McIntosh.

Open vs. Closed Stator Slot Construction, Ans. Ques. No. 311.

Editor Southern Electrician:

In answer to question 311 by F. A. D. in the August issue of Southern Electrician. I offer the following: The partially closed slot requires a form of coil which must either be threaded in through the slot opening or inserted from the end. This type of coil is therefore very difficult to insulate properly for voltages above 550 and open slots

have to be resorted to. With the type of slot that F. A. D. mentions, the coil can be completely insulated and impregnated before being placed in the slot and is therefore more reliable.

By using a partially closed slot, the magnetic effect is similar to using a small air-gap with open slots. Since the exciting current depends directly upon the depth of the air-gap and since the effective air-gap is reduced by using partially closed slots, the exciting current will be reduced and this will mean a higher power factor and increased efficiency. The actual power factor depends upon the leakage co-efficient, which is the ratio between the exciting current and the ideal short circuit current. By using partially closed slots, average air-gap and rather high peripheral speed, the power factor is increased and the output of the machine increased accordingly.

Again the high frequency iron losses caused by the difference in the flux densities over the teeth and the slots are greatly diminished by using slots with small openings. The advantages of the partially closed slot therefore will be greatly reduced if the air-gap is large, as is the case with synchronous machinery, but for induction motors it is very advantageous.

W. D. KELLOGG.

Watt-Hour Output of Storage Batteries, Ans. Ques. No. 316.

Editor Southern Electrician:

In reply to question No. 316 which appeared in the last issue of SOUTHERN ELECTRICIAN relative to the watt hour output of a storage battery, the following may be of assistance to your correspondent.

Batteries are rated by the manufacturers, according to the number of amperes which they will deliver for a specified period of time. For example, a certain type of battery might be rated as follows:

10 amperes for 8 hours, down to 1.75 volts per cell.
14 amperes for 5 hours, down to 1.73 volts per cell.
20 amperes for 3 hours, down to 1.7 volts per cell.
40 amperes for 1 hour, down to 1.6 volts per cell.

You will note that the minimum allowable voltage at the end of discharge decreases as the rate of discharge increases, and that the product of the ampere discharge rate and the time decreases as the rate of discharge increases. In the case given above the normal capacity of the battery would be 80 ampere hours if discharged at a 10 ampere rate, while it would be only 40 ampere hours if discharged at the 40 ampere rate.

I enclose a sketch which shows the characteristic drop in voltage of a lead plate battery of the Central Station type, at various discharge rates. The curves are not plotted from actual figures, but will serve to show the general principle on which the battery operates. You will note that the average voltage during the entire period of discharge is higher at the normal or 8 hour discharge rate and the higher the discharge rate the lower will be the average voltage.

As explained above, the total ampere hours at high discharge rates are less than those at low discharge rates which together with the lower averages voltage at high discharge rates, makes the watt hour output of the battery at high rates considerably less than at low rates. Suppose, however, that a battery is discharged at the 5 hour rate until the minimum allowable voltage is reached, or assuming a specific case, if the battery mentioned above is discharged at a rate of 14 amperes for 5 hours down to 1.73 volts per cell, its catalogue rated capacity would have been obtained. Assume, however, that the rate of discharge was changed from 14 amperes to 10 amperes at the end of 5 hours discharge. The voltage of the battery would rise from the point marked "A" to the point marked "B" and could be discharged for one additional hour at the 10 ampere rate. The total discharge at the 5 hour rate would have netted 14 times 5, or 70 ampere hours, and the additional one hour at the 10 ampere rate would net an additional 10 ampere hours, making up a total of 80 ampere hours or, the normal rating of the battery. The same would be true if the battery was discharged at the 3 hour rate. An additional two hours at the 10 ampere rate could be secured after the battery was apparently fully discharged at the 3 hour rate. In other words, it is the final discharge rate of the battery which determines its ampere hour capacity and it makes no difference whether the rates of discharge previous thereto have been greater or less than normal.

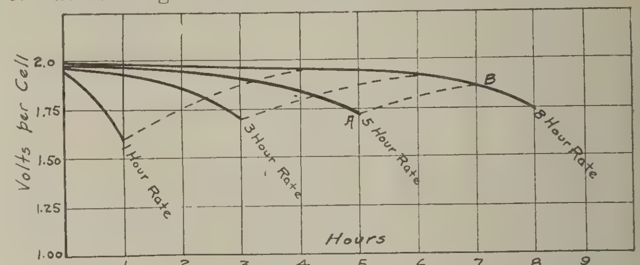


FIG. 1. CHARACTERISTIC DROP IN VOLTAGE OF A LEAD PLATE BATTERY.

Assuming, however, that the final discharge rate is the normal or 8 hour rate, if the previous discharge has been carried through at a higher than the normal rate, for example, the 3 hour rate, the average voltage during the total discharge would be considerably less than if the battery had been discharged throughout at the normal rate and consequently, the watt hour output of the battery would be less.

The converse is also true. If the discharge rates during the first part of the discharge are less than the normal, the average voltage would be high, even if the finish of the discharge was made at greater than normal rate. The reasons for this action are found in the internal resistance and polarization of the cell. Every battery has more or less internal resistance. This is a constant quantity and its effect on the output of the battery can be calculated in accordance with Ohm's law. In addition to the internal resistance, there is a polarization of the plates, the effect of which is to reduce the voltage of the cell. This reduction in voltage increases with the rate of discharge. The fact that a battery, after being discharged at a high rate, will give an additional capacity if the discharge rate is decreased, is explained by the dissipation of the effect of polarization when the rate of discharge is reduced.

A. N. BENTLEY, Mgr. Electric Storage Battery Co.

Somewhat to the surprise of American visitors, electric vehicles are used successfully for taxicabs in Berlin. These now number some three hundred, and were first introduced in 1899. With time and hard usage, a type specially suited to this service has been developed. The most frequently seen is the so-called N. A. G. car, made by the Neuer Automobil Gesellschaft. These vehicles are rated at forty-horsepower, and forty-four cell storage batteries are employed, which can be charged in five hours. Their speed is thirty kilometers per hour, while the mileage is from a hundred to a hundred and twenty kilometers on a single charge.

New Apparatus and Appliances.

An Outdoor Transformer Portable Sub-Station.

A portable sub-station of a new and unusual design has been placed in service on the lines of the Scranton & Binghampton Traction Company. The novel features are the use of outdoor type transformers; the application of Burke horn-type switches, and the general arrangement of the lightning protective apparatus. The general arrangement has been planned so that all of the apparatus will occupy minimum space, but still so that it will be convenient of access and have ample working room around it.

The 440 kilowatt, three-phase, oil insulated, self-cooling, outdoor type transformer is wound for 16,500 volts primary, and rotary voltage secondary, and is secured to the floor with foundation bolts. The high tension conductors from the line are brought down to the roof of the car and connected to the Burke horn-type switches from which they pass through the horn-type fuse and the choke coil and into the primary side of the transformer. On the low tension side of the transformer, the cables drop in conduit directly down through the floor and run through conduit which is supported from the side structure.

A 16,500 volt, 100 ampere, Burke high voltage air break switch constitutes the high tension control. The three movable horns of this switch; one in each phase, are connected by bell cranks, and may be actuated by a standard oil switch which is arranged for automatic operation and is mounted on the switchboard. The horn switches, however, sever the high tension circuit automatically in case of overload. From the switch, the circuit passes through Burke horn-type fuses, which provide further automatic protection of the hightension side of the transformer. The Burke switch is the only switching device in the primary circuit.

A standard Westinghouse low-equivalent arrester provides lightning protection. The arrester is supported between the transformer and the superstructure on a steel framework bolted to the transformer. An ebony asbestos wood casing completely encloses the arrester. The arrester is tapped to the high tension circuit just ahead of the Westinghouse suspension choke coil, and the circuit passes down through disconnecting switches to the arrester. From the arrester, a lead in which is inserted a series resister extends to ground. Where the varnished cambric insulated

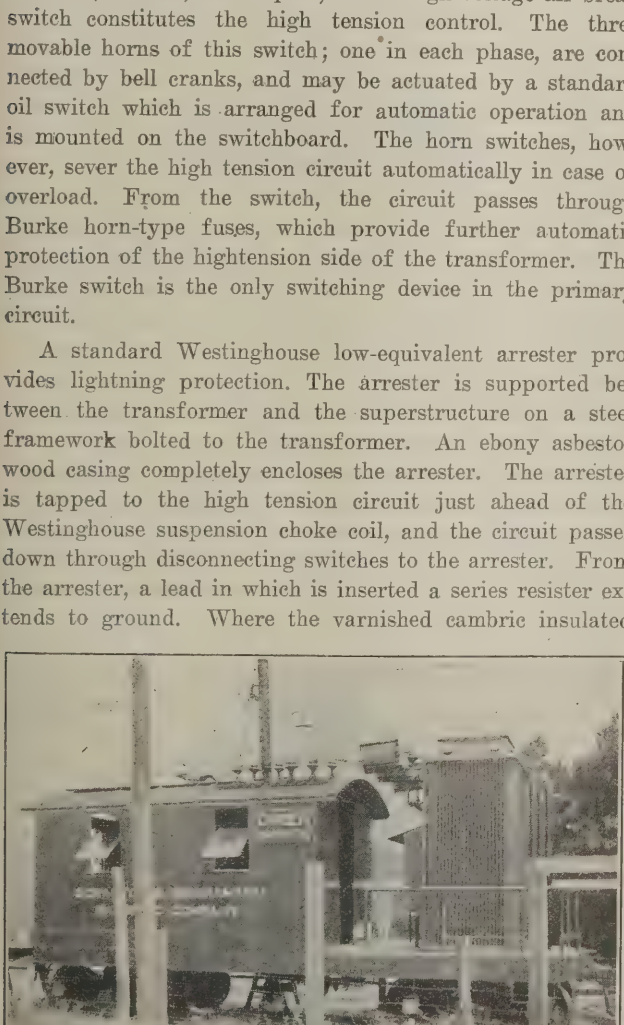


Fig. 1. Outdoor Transformer Sub-Station in Service.

conductor to the arrester passes through the arrester casing, G. & W. pot heads are used to provide additional insulation. A 400,000 circular mil cable, specially insulated with 7/64 inch varnished cambric and with weather-proof braid, extends from the secondary windings of the transformer to the converter. The cable is carried in wrought iron conduit under the car. The function of the conduit is not so much to protect the cable as to provide a convenient means for supporting the cable.

The rotary converter is a 400 kilowatt, 600 volt, 25 cycle, 6-phase, 750 revolutions per minute machine, and is equipped with an oscillator and an overspeed limit device. A leveling arrangement, is provided, by means of which the machine can be accurately aligned when the car is standing on track at a grade as great as 4 per cent.

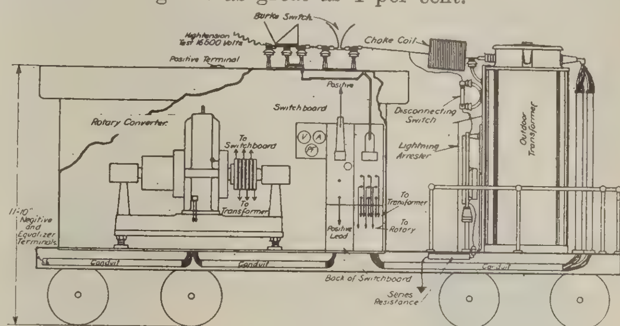


Fig. 2. Sectional Elevation of Outdoor Transformer Sub-Station.

Two 2-inch black slate panels, mounted on an angle iron structure bolted to the floor and braced to the side wall of the car, with a wing for the instruments, constitute the switchboard. The alternating current panel carries the switch handle operating the high tension switch, which is arranged to provide automatic overload protection, and a triple-pole, double-throw, knife switch for starting and running the converter. The direct current panel carries a type C carbon circuit breaker, a rheostat handle, a single-pole knife switch, and a voltmeter receptacle plug. All of the instruments; a direct current voltmeter, a direct current ammeter and a powerfactor meter, are carried on the wing.

Two 400,000 circular mil cables for each negative and one equalizing lead run from the left-hand side of the rotary converter through the floor and through conduit to the end of the car where each pair is soldered into a terminal to which connections can be bolted. The positive lead, which also consists of two 400,000 C. M. cables, runs from the right-hand side of the converter, below the floor, and up back of the switchboard, through the knife switch and circuit breaker to the roof of the car where it is brought out through a condulet fitting. This lead also ends in a terminal to which a connection to the line can be bolted. A Westinghouse MP lightning arrester, supported on the inside of the roof of the car, furnishes lightning protection on the direct current terminal.

For lighting the car there are two five-light clusters which are attached to the car ceiling; one of these is connected to the alternating current circuit, and the other to the direct current circuit. Each cluster is controlled by a

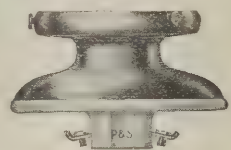
snap switch mounted beside the switchboard. All lighting circuits are carried in National Metal Moulding, which is run inside the channel iron braces.

All of the apparatus in the sub-station is of Westinghouse manufacture with the exception of the horn switches and fuses which were manufactured by the Railway & Industrial Engineering Company, which concern designed and equipped the car. Another car very similar to the one described herein is being built for the Washington & Old Dominion Traction Company, and it will also be placed in service in a few weeks.

New Pass and Seymour Sockets.

The illustration shown herewith are sockets manufactured by Pass and Seymour, Inc., Solvay, N. Y., the one marked No. 429 being a brass shell socket with a 3/8 inch cap made for large base 500 watt lamps. The socket is also made with 1/2 inch cap. The shadeholder is rigidly and permanently attached to the shell. The cap and the shell are all of substantial brass and threaded with a fine thread with a set screw provided on the cap so the lower shell cannot back out of place when properly set up. The center spring contact is of heavy phosphor bronze and the fibre lining may be readily removed for the purpose of refinishing the shell. This device can be supplied either with or without the Shurlok locking attachment.

No. 429



No. 412

No. 1171 No. 1170

New Pass and Seymour Sockets and Fixture Loops.

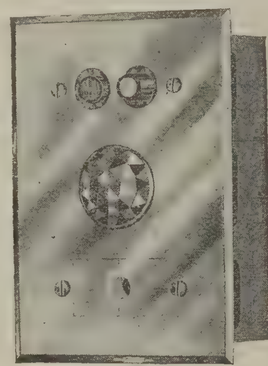
The illustration No. 412 shows an outlet box receptacle designed for use with large base 500 Watt lamps complete with shadeholder rigidly attached. The receptacle sets down into the outlet box and the contact terminals are arranged so that they may be used without cutting the wire.

Fixture loops as shown in Nos. 1170 and 1171 are new P and S products. The former is designer to fit a standard 1/8 inch cap socket, while the latter is a fixture loop with long shank and nut for use with P and S rosettes No. 200 both being used to make up pendant fixtures with chain connecting rosette and socket.

Control of Heating and Cooking Appliances.

Owing to the convenience of their use, the sale of electrical heating and cooking appliances is steadily increasing. However, like all electrical apparatus, they must be correctly installed to insure the full benefit from their use. In this connection, it is well to note the requirements of the National Board of Fire Underwriters. By reference to section 25 of the National Electric Code, electric heaters must be protected by a cutout and controlled by indicating switches. Also, it is advisable to connect in multiple with the heater, and between it and the switch, a low candle power lamp. This arrangement is to prevent the switch being left in circuit while the heater is not in use. For portable devices, the flexible conductors must be connected to an approved plug and receptacle, the plug of which will be pulled out of the receptacle when an abnormal strain is put on the conductors.

To meet the demand for a practical device which would meet the above requirements, the Machen & Mayer Electrical Mfg. Co., 17th and Vine Streets, Philadelphia, Pa. have placed upon the market indicating heater receptacles for installation in residences, laundries, factories, etc. For



An Indicating Heater Controller.

residences and similar installations devices of a capacity of 5, 10, 20, 25, amperes, are used. The devices consists of a suitable switch, lamp and base receptacle, and a flush plug and receptacle. This outfit is mounted in either a steel wall case or cast iron box and covered by a brass face plate having a crystal or ruby cut-glass jewel inserted in it. In installations of this kind, it is advisable to run a separate circuit through it from the panel-board. Hence, no fuses are provided in the box.

For industrial installations, such as tailor shops and laundries where no plug and receptacle is required, a special designed box containing a cutout, a switch, a lamp and base receptacle is provided. The cutout can be either of the cartridge or plug fuse type, and the fuses are accessible by opening the door provided.

New Cutler-Hammer Feed-Through or Cord Switch.

The use of a feed-through or cord switch at the table provides convenient means for controlling the current to heating devices. It eliminates the necessity for operating the fixture socket or for pulling the base plug. The new brass shell cord switch made by The Cutler-Hammer Mfg. Co. of Milwaukee, because of its small dimensions and polished nickel finish is particularly suited for use with

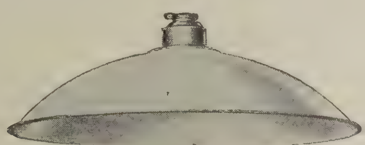
Cutler-Hammer Feed-Through Switch.

heating devices at the table. Convenient operation is provided by simply pushing the button of the switch placed near the device. It is not necessary to hold the switch with one hand and operate it with the other. When used with electric irons it saves the wear on the socket and allows easy and frequent opening and closing of the circuit. When installed the cord passes through the switch, bushings being provided in both caps.

The new insulating material developed in the Ceramic Laboratory of The Cutler-Hammer Mfg. Co., is used as the body of the switch. This material is tough, withstands hard usage, and holds in permanent alignment the small compact operating mechanism, which is similar to that used in the "Acorn" pendant switch recently marketed. This new switch is approved by the Underwriters' Laboratories and bears their label. The rating is 3 amperes, 250 volts, 5 amperes, 125 volts. The illustration is full size.

New Nelite Industrial Reflectors.

The Nelite "Dome" is the latest metal reflector of the Nelite Works of General Electric Company. As the illustration shows, it is a very shallow type of porcelain enameled steel reflector, designed for service where the so-called flat types have heretofore been employed. Its scientific design, however, gives the dome type several advantages, chief of which are the minimum glare effect and the desirable destribution of light both of which are seemed at no sacrifiice of efficiency.



The Nelite Dome Reflector.

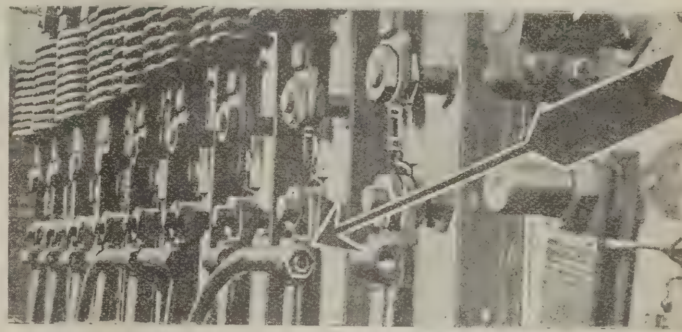
The dome type Holophane—D'Olier reflectors are particularly adapted to service in rooms with low ceilings or where the total area to be lighted is large in comparison with the distance between units.

The Nelite works has greatly improved its steal department manufacturing facilities and methods, since taking over the Holophane business. Heavier steel is now used in the construction of all the smaller sizes of metal reflectors; a method of galvanizing has been perfected whereby the bodies of aluminized reflectors are rendered impervious to moisture and fumes, and an oxi-acetyline process of welding the holders to the reflector bodies is now employed, which makes the finished units as solid as a single piece of metal. These developments have been carried on under the direction of Mr. Henry D'Olier, Jr., who promises further improvements in the Nelite lines of metal reflectors within the next few months.

A Terminal By-Pass.

The Electrical Specialty Co., of Bartlesville, Okla., has recently patented and placed on the market a by-pass attachment for a switchboard. The functions of this by-pass are to permit the repair or cleaning of oil switches and circuit breakers or the transfer of current to any other panel board without interrupting the service. In connection with a new equipment, the switchboard may be equiped with the by-pass and the expense of an auxiliary panel board saved. The device is however applicable to any switchboard at a very small cost.

From the accompanying illustration showing the by-pass installed, it will be seen that the parts consist of a lug attached to the proper switchboard terminal and into which fits a tapered plug provided with threads and a nut a' its end to secure it when it is inserted into the lug as s'.own.



By-Pass Installed on a Switchboard of Metropolitan Street Railway Company.

The by-pass is designed in different ampere sizes with the parts ample for the current specified. A proper sized cable soldered to the tapered plugs forms the jumper and the device is complete. The Metropolitan Street Railway Company of Kansas City, Mo., has recently placed a number of the devices in operation.

Electric Flashing Signs on Auto Trucks.

The latest development in auto delivery trucks brings into use electric signs, by which a decidedly forceful and effective means of advertising a business house is accomplished.

A reco flasher, has been specially designed for this service by the Reynolds Electric Flasher Mfg. Co., and flashes the sign first red, then pink, then white, then green, giving an unusually attractive color-changing effect. Electrical effects practically without limit are possible with flashers, such as spelling a word letter by letter, trade marks, fancy borders, lightning flashes, flaming torches, moving figures, and in fact any effect obtained in electrical display signs can be duplicated on the auto truck. The flasher referred to is built strong and compact and occupies a space 8 x 8 x 6 inches under the driver's seat. The current to operate the sign, flasher motor, as well as all other lights, starter and ignition, is supplied by a new and simple system of generation; the surplus is transferred to storage batteries, which supply current while the engine stands still.

Electric Sign on Auto Truck.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

ATTALLA. It is understood that the Alabama Power Development Co., of Talladega will extend transmission lines to this place at an early date. It is also understood that a transmission line to Anniston, Ala., is under construction and an auxiliary plant is contemplated at Gadsden.

FLINT ROCK. Plans are being prepared for the installation of an electric light plant.

GADSDEN. According to reports the Alabama Power Co., will commence the construction of a large power plant at Lock 12 on the Coosa River, the ultimate capacity of which will be 42,000 Hp.

FLORIDA.

GAINESVILLE. The city is planning the building of an electric light and gas plant. Other information can be secured from the mayor.

HASTINGS. The Hastings Cold Storage Co., will construct an electric light plant and erect power plant buildings. The plant will be of sufficient capacity to operate both the cold storage and electric light plant and will cost approximately $10,000.

TAMPA. According to reports the Tampa Electric Co., will make extensive improvements to their present generating equipment. A tract of land directly opposite its power site has been purchased.

WINTER GARDEN. The Winder Garden Light & Water Co., are planning to combine the electric and ice plant to cost about $20,000.

GEORGIA.

AMERICUS. The Americus Power Co., has reached no definite arrangement with the present lighting company and will commence work on a new power plant in the city.

DALTON. The city council and the officials of the Georgia Railway & Power Co., of Atlanta are considering arrangement whereby the latter company can extend its transmission lines into Dalton.

EATONTON. The city has employed Solomon-Norcross Co., ot Atlanta to design an electric light and power plant.

SWAINSBORO. Plans are now formulated for the installation of an electric light plant for which bonds to the amount of $7,500 have been voted.

VALDOSTA. The Valdosta Lighting Co., successors to the Consolidated Ice & Power Co., expects to build a transmission line and install new equipment. The general manager is W. D. Eager.

KENTUCKY.

EMINENCE. It is reported that H. M. Byllesby & Co., has purchased the electric light plant at this place and will enlarge it to supply day service and furnish power to New Castle, and other nearby towns.

HODGENVILLE. It is understood that Emmett Smith of Chicago, is negotiating for the extablishment of a new electric light and power plant at this place.

LAWRENCEBURG. According to reports Samuel Insull and Associates of Chicago have purchased the electric light plant at Lawrenceburg and will increase its capacity.

LOUISVILLE. The Louisville Lighting Company plans to extend its transmission lines to Jefferson, Ky., and already has a 20-year franchise to supply electrical energy in that city.

RICHMOND. According to recent report the Dick River Power Co., has made arrangements to purchase electric power plants at Richmond, Danville, Frankfort, Versailles, and Lawrenceburg. It is understood that other plants will be purchased and combined with these above.

LOUISIANA.

DONALDSONVILLE. The mayor and a committee of representative business men are considering the installation of a municipal lighting plant. It is understood that the capacity of the system desired will cost about $40,000.

NORTH CAROLINA.

HICKORY. The Thornton Light & Power Co., has increased its capital stock to $125,000.

SCOTLAND NECK. On the system of the Municipal Electric Light and Power Plant at this place, 34 street lamps have been replaced by 50 series tungsten lamps, 30 of which are 250 watt and 20 125 watt. The changes are being made in the system from direct to alternating current at 2300 volts primary and 110 volts secondary 60 cycle. A 90 Kw. generator is being installed.

TURNERSVILLE. It is reported that T. L. Hall has under consideration the purchase of the equipment of the Citizens Light & Power Co., plant and contemplates extending a transmission line to Oakridge Institute.

SOUTH CAROLINA.

CAMDEN. Gilbert C. White, of Durham, N. C., has been engaged to prepare plans for an electric light plant and water works system to cost approximately $100,000.

SPARTANBURG. The Appalachian Power Co., of Spartanburg has purchased lands and water power rights near Henderson, N. C., where 50,000 Hp. will be developed for transmission to other points at suitable locations on the French Broad River. Ladshaw & Ladshaw of Spartanburg are engineers and those financially interested in the projects are Mr. H. L. White, Morris Bomar, John A. Law, all of Spartanburg.

TENNESSEE.

ATHENS. The Tennessee Power Co., is making preparation for the erection of a transmission line from Athens to Etowah. The Company also plans to build a line from Parksville by way of Cleveland to Nashville. Work on these lines will begin at once.

JONESBORO. The Tennessee Eastern Electric Co., has purchased the plant of T. F. Hartis of Jonesboro and will install new machinery. It is understood that this plant will be used as a substation through which current will be distributed from a hydro-electric plant to be built on Clinch River near Greenville, Tenn.

INDUSTRIAL ITEMS.

THE HOLOPHANE COMPANY has recently moved its general offices from Newark, Ohio, to Cleveland, where it will occupy an entire floor of the Vickers Building located at 66th Street and Euclid Avenue. As previously announced, the Holophane Company and the Fostoria Glass Specialty Company of Fostoria, Ohio, are being merged into one, and it is probable that a new name will be given to the combined organization. Definite announcement upon this point has not yet been made. Although all details of the new organization have not yet been worked out, it is known that the sales and engineering departments will be directly in charge of V. R. Lansingh and the manufacturing department under E. O. Cross.

JOHNSON ELECTRIC COMPANY. By the reorganization and enlargement of the Johnston Electric Co., located at 411-13 South Tenth Street, into the Mid-West Electric Co., just announced, Omaha secures one of the largest, if not the largest, electrical supply houses west of Chicago. While the location will remain the same for the present, the stock and trade facilities will be greatly increased, and an almost entirely new management will push the business into a larger territory than ever before. George W. Johnston, the founder of the late company, and for twenty-five years in the electrical supply business in Omaha, remains with the new company as its president.

THE MECHANICAL APPLIANCE COMPANY, of Milwaukee, manufacturers of Watson motors, owing to extensions in its line of alternating current single-phase and poly-phase motors, has just moved its offices and engineering department into a newly erected office building. The extra space made available through the removal will be used for manufacturing purposes.

THE THORDARSON ELECTRIC MANUFACTURING COMPANY announce that since April 25th the office and factory has been situated at 501-515 S. Jefferson St., corner of Congress St., Chicago. Few concerns have shown such rapid strides as the Thordarson Electric Company since its incorporation in 1896. It has created a deserved reputation for the best in electrical apparatus. Its new quarters will afford much larger and

better manufacturing facilities and more available space to carry a larger stock, also a conveniently arranged display room in which their complete line of commercial and laboratory specialties will be displayed.

THE DUNCAN ELECTRIC MANUFACTURING COMPANY, LaFayette, Indiana, is now supplying the trade with a full line of A. C. and D. C. watt-hour meters, and are calling special attention to their new A. C. induction watt-hour meter Model M, which has a driving torque of 109 millimeter grams; also their new Model R shunted type D. C. switchboard watt-hour meter. The Model R switchboard watt-hour meter is of the multipolar type and is guaranteed to be positively astatic. It is finished in either polished copper or hard rubber black, and for switchboard work is described as presenting a most pleasing appearance. The Duncan Company is also designing a full line of sign lighting and bell ringing transformers, descriptive and illustrated matter pertaining to same being mailed upon application.

THE H. W. JOHNS-MANVILLE COMPANY moves to larger quarters. The executive offices and New York show rooms of the H. W. Johns-Manville Co., manufacturers of asbestos, magnesia and electrical supplies, were moved on April 20th to the new twelve-story "H. W. Johns-Manville Building," Madison Avenue and 41st Street, New York City, from their old quarters at 100 William St., where they have been located for the past 15 years. This move marks the 54th anniversary of the company. Under the name of H. W. Johns Manufacturing Co., the business was conducted at 87 Maiden Lane, previous to May 1st, 1897, when it was moved to 100 William Street. In 1901 the firm name was changed to H. W. Johns-Manville Company, a consolidation being effected between the Manville Covering Co., of Milwaukee, Wis., and H. W. Johns Mfg. Co. This last combination brought together two of the largest manufacturers of pipe and boiler coverings, packings, roofings, etc., in the world, and the growth of the company since that time has been almost phenomenal.

They now have factories located in Brooklyn, N. Y., Milwaukee, Wis., West Milwaukee, Wis., Hartford, Conn., and Newark, kee, Wis., West Milwaukee, Wis., Hartford, Conn., Nashua, N. H., Lockport, N. Y., and Newark, N. J., with an asphalt refinery at South Amboy, N. J., and extensive asbestos mines at Danville in the province of Quebec, Canada, which are the largest in existence and produce an exceptionally fine grade of asbestos. They also have a branch house in every city of any size in the United States and Canada, as well as representatives in about all foreign countries.

MATHIAS KLEIN & SONS, of Chicago, have recently sent to the trade a folder giving a brief review of the growth of the company and its business. In this circular it is stated that the business of the present company was organized by Mathias Klein in 1857 in the city of Chicago, on a very small basis. It was not until during the early 60's when the taking over the Illinois and Mississippi Telegraph Co. resulted in the formation of the Western Union Telegraph Co., that Mr. Klein came in contact with the construction department of this company and began the manufacture of lineman's tools. The Chicago fire burned Mr. Klein's shop on Dearborn Street, at the site of the present Great Northern Hotel. He rebuilt on this location and remained there until 1881, when he moved his company to its present location on the west side. The manufacturing shop has been added to and at the present time the factory occupies a ground space of 50 by 100 feet and is four stories high. An auxiliary factory 50 by 100 feet is operated on the north side of the city. The west side factory is principally engaged in the manufacture of Klein pliers, while at the north side plant sundry items comprising the line of Klein products are made. The company's growth has been steady and is based upon the determination to maintain the quality, to design on the basis of utility and to execute on the basis of reliability and fitness and to conduct the business on lines of fairness and equity.

DANA PIERCE, electrical engineer of the Underwriters Laboratories, has been placed in charge of the New York office at 135 Williams Street, New York City. Here Mr. Pierce as electrical engineer of the laboratories hopes to afford electrical manufacturers through the testing stations both in Chicago and New York, improved facilities for obtaining opinions and reports upon their products with increased promptness and efficiency.

THE NORTHERN ELECTRICAL COMPANY has recently opened a new house at Minneapolis. This local house will conduct a general supply and contracting business, specializing on appliances for the home, office and factory. The Minneapolis house of this company will be conducted under the management of Fred G. Dustin, a gentleman well known in the electrical field.

For a number of years Mr. Dustin has been Chief Electrical Inspector of Minneapolis, President of the Minneapolis Electric Club, Associate Member of the American Institute of Electrical Engineers, Past President of the Western Association of Electrical Inspectors, President of the Northwestern Electric Show Association, and former Treasurer of the State Board of Electrical Examiners.

THE WESTERN ELECTRIC COMPANY has recently secured an order from the Birmingham and Southeastern Railway Company for apparatus to equip the way-stations with selective signalling telephone apparatus. The circuit will be about 46 miles long from Union Springs to Eclestic, Alabama. The Central of Georgia has also placed an order with this company for apparatus to be used in extending its telephone train dispatching system. In general, the equipment is to be the same as that furnished for the section of road recently so equipped from Columbus, Georgia, to Birmingham, Alabama. At present there is a short section of road from Macon to Bolingbroke, Georgia, about fifteen miles in length, on which a seven station telephone blocking system has been used. This line is to be converted and extended to Atlanta, a distance of about one hundred and five miles, as a selective telephone train dispatching system.

CROCKER-WHEELER COMPANY. The increasing business of the Crocker-Wheeler Company on the Pacific Coast has caused the transfer of J. E. Fries to the San Francisco office of Pacific Coast Engineer. With this addition to the present organization, prompter service than ever can be given to current inquiries. On April 1st the company opened an office in the Title Insurance Building, in Los Angeles, Cal.

THE JOSEPH DIXON CRUCIBLE COMPANY, of Jersey City, N. J., is sending to the trade and to others upon request, a little book entitled, "Joseph Dixon, one of the World Makers." The book was written by Elbert Hubbard, the sage of East Aurora, N. Y., and in his characteristic style. It is nicely bound and a tribute to the founder of the Dixon Company well worth reading.

H. W. JOHNS-MANVILLE COMPANY, announce a change of their office location in Louisville. Owing to their fast increasing business in Louisville, Kentucky, the H. W. Johns-Manville Company have found it necessary to move their offices from the Lincoln Savings Bank Building to 205 Paul Jones Building. These new and more spacious quarters are much better adapted to their requirements. The office will be in charge of Mr. J. R. Chowning, who is well and favorably known throughout that section, having traveled in that section from the Milwaukee Office a considerable time.

The rapidly increasing demand in Pittsburgh and vicinity for the Asbestos, Magnesia and other products of the H. W. Johns-Manville Co. has necessitated a move from their present location in Liberty Avenue, above Ninth Street, to larger quarters. Since January 24th, 1912, the Pittsburgh Branch of the H. W. Johns-Manville Co. has occupied the entire eight-story stone, reinforced concrete and steel building at the northeast corner of Wood and First Avenue, which has been leased by them for a term of years.

TRADE LITERATURE.

SWITCH BOXES. The Economy Switch Box & Mfg. Co., of Cleveland, Ohio, has issued catalogue No. 6, displaying and describing outlet, junction, and conduit boxes, etc. This catalogue contains considerable information for those who are interested in devices which are practicable and serviceable.

ACME ELECTRIC COMPANY, Knoxville, Tenn., contractors, engineers, designers and supply dealers, have published an announcement under date of March, 1912, which takes up the work which the company is doing and the service which it is prepared to render as engineers and supply dealers. It also contains illustrations of devices designed by the company's engineers.

RADIATION PYROMETERS. The Thwing Instrument Co., 445 North Fifth St., Philadelphia, Pa., manufactures an instrument measuring high temperatures. The operation features and description of this instrument are contained in Bulletin No. 2 published by the company. Numerous illustrations are given and the theory of the instrument explained. Bulletin No. 3 describes type A records, which operate on the thermo-electric principle. These recorders give an accurate and complete knowledge of temperature in all industrial operations in which heat treatment plays a part. The bulletin gives considerable information descriptive of these recorders, together with illustrations.

BRONZE. The products of the Damascus Bronze Co., are described in a bulletin recently issued by this company. The process is briefly outlined and numerous views presented showing parts of Damascus factory.

GAS ENGINES. Catalog No. 28, published by the Otto Gas Engine Co., of Philadelphia, Pa., presents illustrations and data

in connection with the different types of gas engines and direct connected electric lighting sets, manufactured by the company. Bulletin 35 is devoted particularly to low voltage Otto Electric Plants, and contains much material of interest to those installing such plants or contemplating the purchase of them. Bulletin No. 10 is devoted to the Otto Gas and Gasoline engines of 40 to 30 horsepower. A portion of the material is descriptive of the parts of the engine giving various illustrations showing the design.

REFLECTORS. The Opalux Company, of 258 Broadway, New York City, has issued Bulletin No. 11, descriptive of Opalux reflectors, which are called the glass without the glare. The various designs manufactured by the company are shown in this bulletin with the descriptive matter relative to each. Commercial data on reflectors is also given, together with the prices.

CONDUITS. The H. W. Johns-Manville Co., of 100 William St., New York City, has issued Bulletin No. 112, taking up sectional conduit for insulating pipe conveying steam, water, gas or liquids underground. Bulletin contains 44 pages with many illustrations, data and tables on conduit systems. Numerous installation layouts are also given, showing steam conduit installed.

SERIES TRANSFORMERS. The Conduit Electrical Mfg. Co, of Boston, Mass., has issued an advance price list of series transformers.

LIGHTING SPECIALTIES. The H. W. Johns-Manville Co., of New York City, has issued catalogue No. 408, descriptive of lighting specialties, and reflectors as manufactured by the I. P. Frink Co. The H. W. Johns-Manville Co. acts as sole selling agents for products of the I. P. Frink Co., and the bulletin mentioned is devoted principally to modern illuminations for insurance companies and banks. Considerable information is given and various features of bank lighting displayed.

MAGNETIC CHUCKS. The D. & W. Fuse Co., of Providence, R. I., has issued circular No. 202, descriptive of D. & W. magnetic chucks.

D. C. TURBO-GENERATORS. The Westinghouse type T direct-current turbo-generator, consisting of a Westinghouse steam turbine direct-connected to, and mounted on, a common base with a direct-current generator, is fully described and illustrated in descriptive leaflet 2458 just issued by the Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa. A full description of the various characteristics and construction details of the turbine is given, and numerous views of the component parts of the various elements, the completed machines, and installations are shown.

TELEPHONE SUPPLIES. The latest bulletin the Kellogg Switchboard and Supply Company have to offer the trade is the Number 60, on Construction Material, Tools and Miscellaneous Supplies. Every effort has been made to list in this bulletin the best materials, apparatus, etc., of proven merit, and in this way the customer may obtain what he needs with the assurance that he is not buying something of doubtful efficiency. This book also serves as a right hand aid, and guide to good line construction, advising in its different chapters, the best way to handle different phases of telephone line construction.

A LITTLE JOURNEY. One of the most unique contributions to the recent N. E. L. A. convention in the way of souvenirs was made by the National Quality Lamp Division of the General Electric Co., at Cleveland. This souvenir consists of a booklet bound in limp leather and contains much information on electrical matter to be seen along the various trips to Seattle, Wash. The book is essentially a diary and is arranged with spaces for recording events and data from Sunday, May 26th, to Sunday, June 23. It contains seventy-eight pages and neatly bound and printed. The first article is written by Elbert Hubbard and entitled "Thoughts on Electricity." This material is characteristic of this noted author's style, and relates many features of general interest.

P. AND S. READY WIRED MATERIALS. Bulletin No. 720 of Pass and Seymour, Inc., Solvay, N. Y., gives complete details of P. and S. ready wired sign receptacles, porcelain and mica sockets, and porcelain receptacles. These are especially adopted for decorative schemes and outlining buildings and are carried in stock in 500 feet lengths wired with No. 14 and No. 12 wire.

TRANSFORMERS. The Maloney Electric Co., of St. Louis, Mo., has issued a very instructive catalogue on the types of transformers they manufacture. The bulletin contains 56 pages and a feature is the information and diagrams presented on core loss, copper loss, and regulation tests. Much other information is contained in it also that will be found of value.

ELECTRICAL SPECIALTIES. The Chelten Electric Company of Philadelphia, Pa., has issued a revised bulletin covering their line of switches, receptacles, wall cases, ground clamps, etc. Description, illustration and prices are included.

REFILLABLE FUSES. A. F. Daum Co., of Pittsburgh, Pa., has issued a catalogue under date of May, 1912, covering all the details of their refillable fuse, giving prices.

CABLE SPECIALTIES. The Specialty Device Co., of Cincinnati, Ohio, has issued catalogue one covering cable sleeves, rollers, and pot heads. Description, illustrations and prices are given.

THE KENNEDY CLAMP. The States Co., of 202 W. Water St., Syracuse, N. Y., has issued a folder describing the Kennedy Clamp for use in street lighting, transformer service and where it is necessary to run conductors vertically.

D. C. GENERATORS. Circular 1194, issued by the Westinghouse Electric and Manufacturing Company, covers Type Q, direct-current engine driven generators, and describes their construction very fully as well as illustrating the various parts. Quite a number of installation views of this type of generator are also shown.

FLASHERS. The Reynolds Electric Flasher Mfg. Co., of Chicago, has issued bulletin No. 21 giving a number of the latest flashing suggestions and a few of the most catchy and original effects that can be operated by the flashers they make. Sign men will be interested in this bulletin.

OUT-DOOR TYPES TRANSFORMERS. Descriptive leaflet 2496, issued by the Westinghouse Electric and Manufacturing Company, describes their out-door type, oil insulated self-cooling transformers. These transformers are of the same construction as those built for indoor service with the additional features necessary for installation outdoors. The leaflet describes the details of construction and shows several views of outdoor installations.

CARBON BRUSHES. The Corliss Carbon Co. has issued a price list and catalogue of their products which are especially designed for generator and motor service.

MOTOR CONTROLLERS. The Reliance Electric & Engineering Company of Cleveland, Ohio, has issued Bulletin No. 7010 descriptive of an automatic starting controller for motor driven machinery. This device is particularly applicable to machine tools.

ELECTRIC FLASHERS. The Reynolds Electric Flasher Mfg. Co., of 617 West Jackson Blvd., Chicago, Ill., has issued bulletin and price list No. 18 taking up in detail the Reco Flasher for selling, chaser, lightning, adjustable and three color signs. Considerable information is given in the bulletin on wiring schemes and on the size and capacity of the various flashers for these schemes.

ADAPTER BOX. The Bonnell Mfg. Co., of Cleveland, Ohio, has devised an adaptable conduit fitting which lends itself to numerous combinations and employs comparatively few parts for this purpose. The device is built up on a base which is a casting with four supports. These supports hold both the side plates and covers so that the assembled adapti box is as solid as a piece of iron. Electrical contractors will be interested in this device, since a less investment is required for a complete stock of adapti boxes than for equal variety of any other fitting for similar use.

INDICATING ENCLOSED FUSES. The Detroit Fuse & Mfg. Co., of Detroit, Mich., has issued pamphlet No. 22 describing the Arkless indicating closed fuse. This fuse has a positive mechanical indicator in the form of a spring connected to a weakened portion in the fusable strip, so that when the fuse strip is disrupted an indication of this condition must occur.

ELECTRICAL SPECIALTIES. The Tregoning Electric Mfg. Co., of Cleveland, Ohio, have issued catalogue and price list No. 4 taking up Tregoning Electrical Specialties. Complete details are given on attachment plugs, rosettes, combination cleat and receptacles, pendant receptacles, sign receptacles, etc.

DIRECT CURRENT MOTORS AND GENERATORS AND POLYPHASE INDUCTION MOTORS. The Ideal Electric & Mfg. Co., of Mansfield, Ohio, has issued bulletins Nos. 1011 and 1031, the former describing direct current motors and generators and the latter polyphase induction motors. Both catalogues describe and illustrate fully the products, giving feature of electrical and mechanical construction.

COPPER HISTORY. The Rome Wire Co., of Rome, N. Y., has issued a pamphlet giving the monthly prices of copper since 1883. The pamphlet will be sent upon application to any one interested.

CEMENT POLES. The Standard Cement Pole Company of America, located at 25 Broad street, New York, is preparing to place on the market reinforced cement poles. These poles are manufactured under the so-called Rubello-Santi system and in such a way that the reinforcement is rigidly held in position as though it were one piece. In these poles the reinforcing members consist of a plurality of metallic rings embedded concentrically in the concrete and variably interspaced. All the rings are united by steel rods which run parallel through a number of perforations with which the rings are provided. The above company controls the Rubello-Santi system under patents relating to reinforced concrete cement construction for hollow poles.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

Fuses-Cartridge Enclosed.

CORRECTION. Under the above heading on page 375 of the August issue an error appears in connection with each of the items. The Underwriters' Laboratories have not approved these cartridge enclosed fuses and have in each case rendered a criticism. The date appearing on the items mentioned is that of the latest underwriters report.

Cabinets.

KOSCHIN CO., 269 Clinton St., Milwaukee, Wis. Standard for N. E. Code requirements. Approved June 27, 1912.

OREGON WELDING & MFG. CO., 305 Glisan St. Portland, Oregon. One piece steel cabinets with welded joints. Reported on July 5, 1912.

Conduits, Flexible Steel.

FLEXIBLE CONDUIT CO., Penn Yan, N. Y. Standard flexible steel conduit. Approved June 24, 1912.

NATIONAL METAL MOLDING CO., Fulton Bldg., Pittsburg, Pa. "Flexsteel" flexible steel conduit. Approved June 25, 1912.

SAFETY ARMORITE CONDUIT CO., Bailey-Farrell Bldg., Pittsburg, Pa. "Sterling" flexible steel conduit. Approved June 22, 1912.

SPRAGUE ELECTRIC WORKS OF G. E. CO., 527 W. 34th. St. N. Y. City. Greenfield flexible steel conduit. Approved June 26, 1912.

Conduit, Rigid.

MARK MFG. CO., Chicago. "Navalite" standard conduit. Approved July 11, 1912.

NATIONAL ENAMELING & MFG. CO., Youngstown, Ohio, C. S. Knowlesc, sole agent, 7 Arch St., Boston, Mass. "Enamelduct," "Alumaduct," "Alumaduct Special," enameled conduit. Approved June 7, 1912.

Fixtures, Wire.

BELDEN MFG. CO., 23rd St. and Western Ave., Chicago, Ill. Marking: Blue and yellow threads laid parallel with wire between rubber insulation and braid. N. E. Code 1911. Approved July 11, 1912.

BOURN RUBBER CO., Providence, R. I. Marking: Three green threads parallel in braid. N. E. Code 1911. Approved July 8, 1912.

ELECTRIC CABLE CO., Bridgeport, Conn. Marking: Red and black threads parallel with wire between the rubber insulation and the braid also one blue thread woven in the braid. Approved July 8, 1912.

ROEBLING'S SONS CO., John A., Trenton, N. J. Marking: One red thread and one blue thread woven in the braid. Approved July 9, 1912.

Panelboards.

BASELER AND HEINEKEN, 537-545 S. Seventh St., Camden, N. J.. Two-wire, 125 and 250 v. and 3-wire 125-250 volts with or without main line and branch switches. Approved June 17, 1912.

CLEVELAND SWITCHBOARD CO., 430 Prospect Ave., N. W., Cleveland, Ohio. Two and 3-wire Panelboards, 125, 125-250 and 250 volt with double pole knife switches in branch circuits, open link, Edison plug or cartridge enclosed fuses. Approved June 17, 1912.

CUTHBERT ELECTRICAL MFG. CO., 105-109 S. Clinton St., Chicago, Ill. "Cuthbert" panelboard, 125, 125-130 and 250 volts, two and three-wire with double pole knife or snap switches, link, plug or cartridge fuses. Approved June 17, 1912.

ELECTRIC MFG. CO., 926 Lafayette St., New Orleans, La. 125 and 250 volts, two and three-wire with knife switches, and terminals for cartridge fuses. Also two and three-wire meter panel. Approved June 17, 1912.

ELECTRICAL MFG. CO., 1363 W. Second St., Cleveland, Ohio. "E. M. Co." two and three-wire panelboards, 125 volts with or without knife switches in branch circuits, open link or cartridge fuses. Approved June 17, 1912.

KRANTZ MFG. CO. H., 160-166 Seventh St., Brooklyn, N. Y. "Jones" universal metering panelboard and others for use where installed in approved steel cabinets. Approved June 27, 1912.

LEONARD-BUNDY ELECTRIC CO., Cleveland, Ohio., two and three-wire panel boards for 125-250 and 250 volts branch circuits. Approved June 17, 1912.

METROPOLITAN ENGINEERING CO., 1250 Atlantic Ave., Brooklyn, N. Y. "M. E. Co." Metering panelboard. Approved June 17, 1912.

METROPOLITAN ELECTRIC MFG. CO., East Ave. and 14th St., Long Island City, New York City. "Metropolitan" 125 and 250 volts, all capacities. Approved June 17, 1912.

NIELSEN COMPANY, L. H., 341 Sixth Ave., Pittsburg, Pa. "Nico" two-wire, 125 and 250 volt and three-wire, 125 and 250 volt, with or without main line and branch circuit switches. Also "Nico" metering panelboards. Approved June 17, 1912.

NYELEC SWITCHBOARD CO., 485 First Ave., New York City. Two and three-wire panels for 125, 125-250 and 250 volts. Approved June 17, 1912.

PAISTE COMPANY, H. T. 32nd and Arch Sts., Philadelphia, Pa. "Panelettes" 125 and 250 volts porcelain base units carrying cut-outs and knife switches. Approved June 17, 1912.

PENN ELECTRIC & MFG. CO., Irwin, Pa. Two-wire for 125 or 250 volts, three-wire for 125-250 volts, with or without main line knife switches and cut-outs. Approved June 17, 1912.

PIKE ELECTRIC MFG. CO., 6-10 Central Ave., Minneapolis, Minn. "Pike" panelboards. Two-wire, 125 volts, three-wire 125-250 volts, Edison plug cut-outs in branch circles, with or without knife switches in branches and main lines. Approved June 17, 1912.

PITTSBURG ELECTRICAL & MACHINE WORKS, 1-2 Barker Place, Pittsburg, Pa. Three-wire for 125-250 volts, two-wire for 125 and 250 volts, with or without main line knife switches and cut outs. Approved June 17, 1912.

ROCHESTER SWITCHBOARD CO., 5 Prospect St., Rochester, N. Y. Two-wire panelboards, 125 and 250 volts. Three-wire, 125-250 volts. Approved June 17, 1912.

TRIO MFG. CO., 2424 Third Ave., Rock Island, Ill. Two-wire, 125 volts and three-wire, 125-250 volts with or without main line and branch circuit switches. Approved June 17, 1912.

WORCESTER ELECTRIC MFG. CO., 42 LaGrange St., Worcester, Mass. "Worcester" two and three-wire panels, 125, 125-250 and 250 volts. Approved June 17, 1912.

WURDACK ELECTRIC CO., Wm., 17-19 N. 11th St., St. Louis, Mo. Two and three-wire panelboards, 125, 125-250 and 250 volts with or without main line knife switches and fuses. Approved June 17, 1912.

Electric Signs.

GUDE CO., O. J., 2,001 Broadway, New York City. Electric signs in accordance with N. E. Code. Approved July 8, 1912.

NATIONAL ELECTRIC SIGN CO., 61-63 Hudson St., Jersey City, N. J. Electric signs in accordance with N. E. Code. Approved July 8, 1912.

Switches, Surface Snap.

KNOWLES, C. S., 7 Arch St., Boston, Mass. "Boston F. and S." switches, 5 A., 250 volts., 10 A., 125 volts. Rectangular base push-button snap switches. Approved July 6, 1912.

PERKINS ELECTRIC SWITCH MFG. CO., Bridgeport, Conn., Ceiling switches, pull type with metal covers. Approved June 27, 1912.

HUBBELL, INC., HARVEY, Bridgeport, Conn. "Hubbell" 3A., 125 v., and 1A., 250 v. An adaptation of the standard Hubbell pull socket mechanism without lamp holder and with closed brass shell with chain outlet centrally located at the bottom. Approved June 22, 1912.

AUTOMATIC CONTROL

Just Press a Button

ENGINEERS realize that the future control of electrical apparatus will be entirely automatic. They do not all realize, however, that there exists today a perfected and proven system of automatic control for electric motor drive.

The **MONITOR SYSTEM** provides a fool-proof, accident-proof way of starting, stopping, reversing, accelerating, retarding or locking the motor. The apparatus is simple, rugged, reliable, and requires little or no maintenance or adjustment. It is positive in action and instantly responsive to controlling movements of the switches. "Just Press a button."

We shall be pleased to co-operate and advise

Monitor Controller Company

111 South Gay St., Baltimore

SOUTHERN ELECTRICIAN

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CONTENTS:

The Incandescent Unit in Present Day Lighting.

From the incandescent lamp with a carbonized bamboo filament of 1880 to the incandescent lamp of today with a drawn wire tungsten filament, there has been a lapse of 32 years and a jump in the efficiency of the unit from about five watts per candle-power to around one and a quarter watts per candle-power, and the end is not yet. No less an authority than Elihu Thomson, in an address before the Franklin Institute, has said that the knowledge gained in the past year or two renders probable a further advance in efficiency of lamps leading to the confidential expectation that more than 50 lamps of 20 candle-power each can be used at an expenditure of only one kilowatt of energy. He further says that these results may possibly be much exceeded for important research to this end is not yet finished. This means that units of the lowest rating will have a lamp efficiency of one watt per candle-power. When one stops to consider that since the commercial birth of the incandescent lamp, generating and distribution systems have been perfected as well, certainly the past 32 years have to their credit the lion's share of the world's progress.

As to the present day use of the incandescent unit and the tendency to adopt the highest efficiency types, we have the report of the N. E. L. A. Lamp Committee as authority for the fact that five years ago 93 per cent of the total sales of domestic lamps were of the carbon type. Since that time a record of each year's sales has shown that there has been a falling off in the output of this type of lamp, with a marked increase in the ratio of the total in favor of the metallized filament and tungsten types. For the year 1911 the carbon lamp sales dropped to 53 per cent of the total with the metallized filament lamp increasing from about 6 per cent in 1907 to about 20 per cent and the tungsten from almost insignificance to more than 25 per cent of the sales of 1911. Indications now point to a further decrease in the carbon lamp output and in this direction it has been conservatively estimated that the output of this type of lamp will be less than 20 per cent of the total for the year 1912. Further, that the gem or metallized filament lamp now operating around 2½-watts per candle-power, will finally take its place altogether. It was the recommendation of the N. E. L. A. committee above referred to that such a movement take place among the association membership, in view of the fact that now the field is covered by the metallized filament lamp in all the important types and sizes.

For something over a year, the tungsten lamp has been available in 15 and 20-watt sizes, and now the 10-watt is a commercial success. Recently an improvement has been made in the larger sizes from 250 to 500 watts on circuits of 100 to 130 volts, so that an operating efficiency of one watt per candle-power has been possible with a life approximating 1,000 hours. Where these larger units have been generally used, most satisfactory results have been secured and in many cases a longer than guaranteed life has

been shown. It is therefore evident that the tungsten lamp, both in large and small sizes is to find an expanding field of general usefulness.

The tungsten lamp continues to invade the field of the arc lamp for both industrial and street lighting. In the former field the use of larger sizes with angle and other appropriate types of reflectors, are meeting with decided success, both in life and illumination. In the field of street lighting, however, the smaller units seem to provide the best means for uniform illumination, lending themselves to the most economical mounting and spacing. The decorative system of street lighting with tungsten lamps also continues to grow in popularity for the business and center of town portions o fthe larger and moderate sized municipalities.

It has in many cases been predicted that the rapid increase in the use of tungsten units and the replacing of the arc lamp in residence sections for street illumination, means the extermination of the latter. With the remarkable development in the flaming and magnetite arcs, it is a fairly safe assumption that the next five years will see a standardization of systems with few of the present types of lighting units altogether eliminated. It is to be expected that the tungsten units will hold sway for inexpensive street lighting in scattered residential districts and in small towns, as well as for decorative lighting in business sections of our cities. However, between these two extremes there is yet a large field to which the arc lamp has long been found admirably suited, and for some time yet it will fill such places of usefulness, perhaps, however, in conjunction with series tungstens, each arranged on the same circuit as conditions dictate.

Lighting Progress by Fields.

According to the information gleaned from the different lamp manufacturers and especially from the National Electric Lamp Association which is sustained by some twenty-one lamp works of the General Electric Company and together represent the seat of a considerable part of the engineering and commercial activity in the lighting field, it is plain that the past year has witnessed a steady growth in development from an illumination standpoint with few spectacular changes in regard to progress in illuminating engineering.

However, considering the progress in the different classes of lighting, as distinguished from lamps and appliances, a vast increase in the amount of interest taken in lighting by the management of industrial plants has been found. High efficiency lamps have been tried out successfully by many industrial corporations and the changing over of their lighting equipment to the high efficiency basis is being accomplished daily.

In the field of ornamental street lighting, many advances have been made. There are now several hundred towns and cities throughout the United States which have ornamental street lighting systems, and which have realized not only the advertising value of good street lighting but likewise the protection against accident and violence that street lighting affords. The most recent installation recalled is that of Battle Creek, Mich., a town, which, like Warren, Ohio, is lighted to its outskirts by incandescent lamps.

In the field of residence lighting, much has been accomplished by the concentrating of many forces toward the commercial development of this field. The equipment has been available for a number of years and the tungsten lamp has made it possible for everyone to afford electric light. The question of extending residence lighting is merely one of educating the public to the fact that electric light is within the reach of all.

Considerable progress has been made in the introduction of tungsten lamps for train lighting and street car lighting. The last mentioned application is rather a new one for the tungsten lamp, but since it has been thoroughly demonstrated that this type of lamp is practical for lighting the New York subway trains, it has opened up a new field for better illumination which enables street railway companies to court the good will of the public by bettering the illumination and at the same time really save money. The field of street car lighting is one that has not been given the attention that it might have received and one that is very far behind commercial development in other fields of illumination.

One notable development which, however, affects only the commercial handling of lamps but indirectly affects increase in use in all fields, is the perfection of a unit carton holding five standard lamps. This means increased convenience for the dealer in handling lamps, less breakage and a greater number of lamps held in stock by the consumer to guard against emergencies. Unremittent research work has now brought the drawn wire tungsten filament to the place where it can no longer truthfully be called fragile, as the tungsten lamps containing this filament are being used in some of the roughest kinds of service. Tungsten lamps are being made in smaller sizes than ever before, and in addition to lamps of higher wattage, the 10-watt, 110-volt lamp is now a reality.

In the gas lighting field there has been a great deal of talk about new types of incandescent mantles, but apparently these mantles do not possess all the merits claimed for them, for they have not found their way into the commercial market to any great extent.

Progress in electric arc lighting has consisted chiefly in improvements in the composition of electrodes and in refinements of the lamp mechanism. No radical improvements have been noted since the appearance last year of the long hour flaming arc. A few installations of quartz tubes have been made in this country, notably in Chicago.

The lamp manufacturers generally have realized more than ever before, the large amount of commercial development that is to be done, and their advertising and sales promotion campaigns are on a larger and more extensive scale than ever before. This work on the part of the manufacturers will produce results for the industry.

Minerals Wasted Annually.

A quarter of a million tons of coal.

More natural gas than the total output of artificial gas companies.

Nearly 90 per cent of the energy of the coal that is mined.

More than 15,000,000 tons of coal through boiler scale in locomotives.

More than $40,000,000 of by-products in the making of coke by old-fashioned process.

Lighting Features and Light and Power Load of a Store and Office Building.

(*Contributed Exclusively to* Southern Electrician)

BY NORMAN B. HICKOX.

An Example of Profitable Results From a Central Station's Activity for Modern and Efficient Electrical Construction.

IN most Oklahoma cities everything in the way of correct illumination for the modern office building is of the very latest type. One reason for this is, that here there is no old installation to replace. It therefore naturally follows to put in for the first time that which is not only most modern, but also what is best suited to the conditions. In Muskogee, especially in the last two years, several large and modern office buildings have been erected. These are all of concrete and steel construction, and would make a favorable showing even if placed in some of our largest cities. These buildings have all been designed by good architects, and as Muskogee is one of the brightest cities in the southwest, especial attention has been given to the proper illumination of the buildings throughout. As a general rule, co-operation between the central station and the architects has resulted in nearly ideal illumination, but with a system that does not tax the pocketbook of the building owner. Careful planning in each case was necessary so as to put in an efficient and economical installation. No special type of reflector has been strictly followed, but where it was deemed necessary to use the opalescent reflector it was used, and where the prismatic reflector was best suited to conditions, it was installed. Muskogee's new half-million dollar hotel has an Alba installation straight through, using the semi-indirect feature in the lobby, dining room and parlors. The new Barnes building, a structure costing somewhat over half a million, is equipped with different types of reflectors, with a very pleasing result.

Norman B. Hickox, Manager New Business Dept Muskogee Gas & Electric Co.

The Muskogee Gas and Electric Company has been a firm advocate of proper lighting installations, coupled with the using of the smallest size tungsten lamps, possible to produce the required results. For instance, in the new Phoenix building the proprietor desired to use 150-watt lamps where 100-watt lamps were sufficient, and it was explained to him that the 100-watt lamps would give him ample illumination, which he later found to be true. At night Muskogee's show windows will get the attention of any person on the streets. There are many hundreds of the X-ray scoop reflectors, most of them equipped with 100-watt clear tungsten lamps. This type of reflector for window lighting is probably more efficient than anything else available. In no case have we failed to give satisfaction by advocating the installation of the scoop.

As explained above, it is possible to secure a very high grade type of installation where buildings are new and where there is no installation to be done away with. In what follows the writer will describe the electrical construction and equipment of one of the notable examples of construction in the new Southwest, recently completed, namely, the new Phoenix building in Muskogee, Oklahoma. It is located at Fourth and Broadway, which is at present near the edge of the shopping district, which will be, however, with the opening of the big ten-story hotel now under construction, one of the most stagetic positions of Muskogee's business district. It is an eight-story and basement building, facing 50 feet on Broadway and 114 feet on Fourth street. The building is of concrete, constructed under the Kahn patents, with walls of light buff brick, supported from each floor with Carthage stone trimmings. The first floor and basement are occupied by the New Phoenix Clothing Co., with one of the most complete and up-to-date men's and boys' furnishing stores in the country. The upper floors are occupied by doctors and dentists and also by several large real estate firms.

INSIDE ARRANGEMENT OF BUILDING.

The New Phoenix Clothing Company's store is one of which any city would be proud. On Broadway, two magnificent curved windows flank the entrance, with the entire 114 feet on Fourth street given over to seven large windows, the construction of which indicates the latest detail in show window construction. The bulkheads are of birdseye maple, finished in natural color, and each window bears a transom of art glass, containing the emblem of the store a phoenix with outspread wings arising from a fire, and bearing the monogram "N. P. C. Co." These bulkheads alone cost $4,000. The dimensions of the front windows are eight feet high by ten feet deep, and each of the side windows eight feet high by three feet deep. Inside the store the thorough carrying out of all details is worthy of mention. To the right extends a row of revolving wall clothing cases, opposite which are a row of glass top revolving floor cases. To the left is first the hat department, and following are the furnishing goods. In the center is a grand stairway, 12 feet wide to the basement. At the rear is a mezzanine floor, which serves as offices. In the basement several unique features are worthy of mention. Here is located the shoe department and a complete line of furnishings for the boys. The whole scheme of fixtures in this basement is carried out as completely as on the first floor. One large

room is divided off at the rear and used as a children's playground, being fitted with "shoot-the-chutes," "merry-go-round" and "see-saws." All of the fixtures and woodwork in the store are finished in light fumed oak. A small office under the big stairway serves the basement and is connected to the main office by telephone and a Lawson consolidated cash carrier. Messrs. Jakowsky and Franks, the proprietors, are two of Muskogee's most progressive citizens, and their policies and methods of doing business are broad ones. They are extensive advertisers, and always awake to any business-building opportunities.

ELECTRICAL EQUIPMENT OF THE BUILDING.

The electrical equipment of the building is carried out in an extensive manner. Every possible chance for the utilization of electricity has been taken advantage of. Two Otis passenger elevators serve the basement and eight floors, landing at street level in a small lobby, from which there is a side entrance into the store. These elevators are 20 hp each, and are equipped in the latest style, having the ball-bearing swivel cable ends, etc. The heating is taken care of by a 10,000-foot American sectional hot water boiler heated by natural gas and supplied with a 240-300 inch per minute Connersville vacuum pump, to which is belted a two hp 1,800 rpm Richmond motor. An additional small boiler is used to heat water during the warm weather for lavatory purposes. The water supply is by gravity pressure, there being a 2,500-gallon tank on the roof, supplying the system. By means of an automatic float switch this tank is filled by an electric pump placed in the basement. A Fairbanks-Morse two hp 1,200 rpm motor belted to a Fairbanks-Morse 40-gallon per minute pump, takes care of this service. A circulating ice water system is installed, the city water being first filtered through a Monitor Hygenia filter, then cooled in a large coil placed in an ice chest, and circulated through the system by a Gould centrifugal circulating pump, to which is belted a Fairbanks-Morse one hp 1,200 rpm motor.

As the basement level is below city sewer level, a small sump takes care of that amount of drainage. The sump is emptied by a 30-gallon per minute straight piston pump driven by a half hp 1,200 rpm Fairbanks-Morse motor. The Lawson cash carrier, which connects the basement office to the main office of the store is operated by a Holtzer Cabot half hp 235 rpm motor. A truck type Atwood vacuum cleaner is in use throughout the building (being moved on the elevators) which is driven by a three hp 1,800 rpm motor. With the exception of the elevator machines, which are on the roof, and the vacuum cleaner set, which is moved from floor to floor, the entire power apparatus is grouped in the basement in one large room, which also contains the lighting and power switchboards.

THE LIGHTING EQUIPMENT.

The lighting equipment above the first floor is similar on every floor, as shown in the typical office floor plan, Fig. 4. The corridor is lighted by seven 40-watt lamps in holophane reflectors, and each of the 15 office rooms with two 40-lamps in holophane reflectors. A close ceiling fixture is used. In addition, each room is supplied with two flush wall receptacles, not controlled by the light switch. The power and lighting wires feeding each floor, rise through a shaft provided, which is directly above the switchboard in the basement, the alternate floors being tapped on the same side of the 220-110 volt three-wire system. All current and lighting is supplied tenants free of charge.

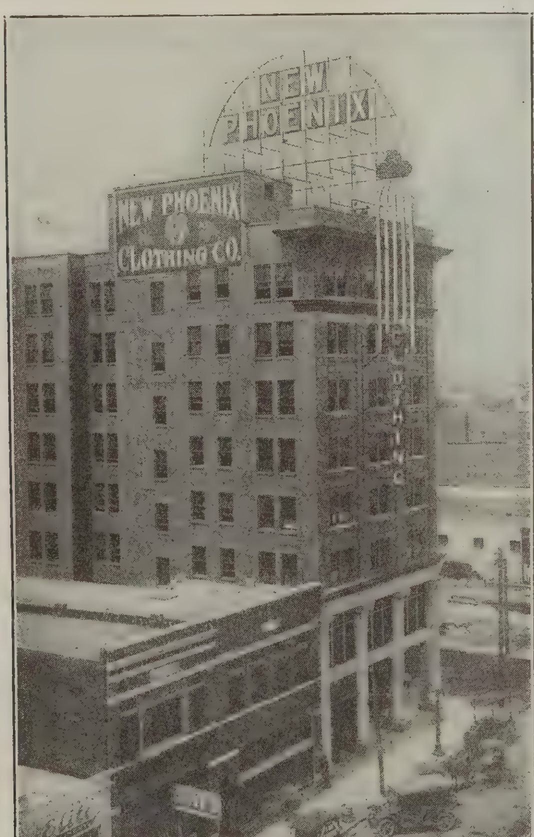


FIG. 1. DAY VIEW OF NEW PHOENIX BUILDING, MUSKOGEE, OKLA.

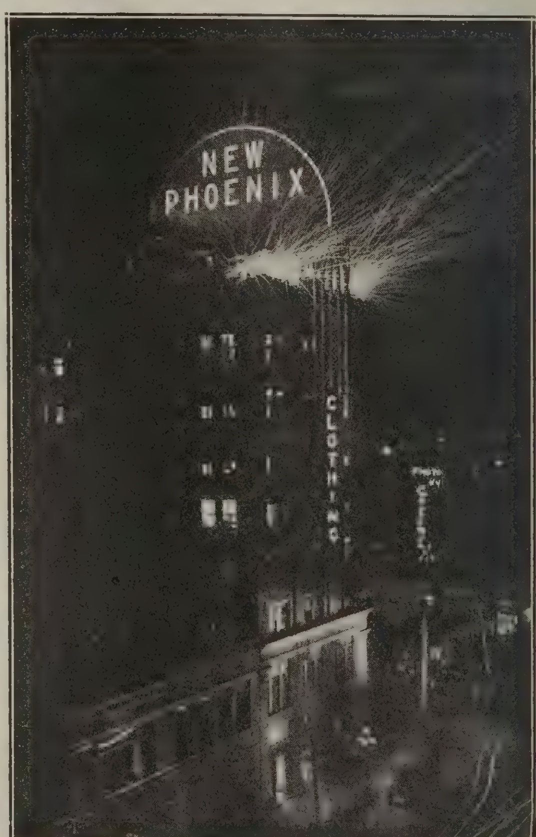


FIG. 2. NIGHT VIEW OF NEW PHOENIX BUILDING, SHOWING ELECTRIC SIGN LIGHTED.

On the curb line, as shown in the street floor plan, Fig. 3, are three five-light Luxolabra standards, each containing five 100-watt lamps, while two immense brackets flank the entrance, each containing one 100-watt lamp. Behind the large pillar which stands between the two front windows, is a unique ceiling fixture containing six 60-watt lamps.

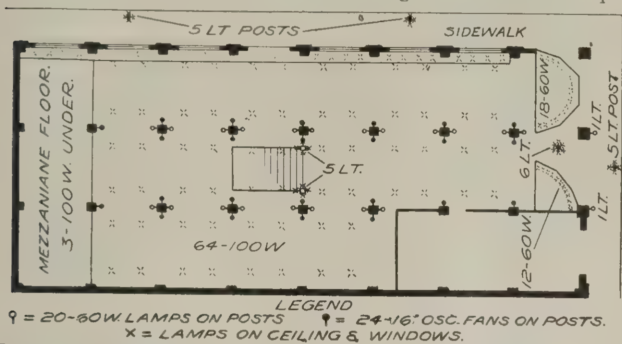


Fig. 3. Street Floor Plan of New Phoenix Building, Showing Arrangement of Lighting Units and Fans.

The front bay windows contain 30 60-watt lamps in X-ray scoop reflectors, and the side windows 28 60-watt lamps in the same type of reflector. The effect produced in window lighting is perfect as can be seen in the illustrations, Figs. 6 and 7. The lighting of the main floor of the store is accomplished by the use of 64 100-watt lamps in holophane reflectors, placed 12 feet above the working plane, and so distributed in single light fixtures as to give approximately seven-foot candles on the working plane. The concrete posts throughout the store are equipped on opposite sides with 24 16-inch mechanically oscillated fans, while the remaining sides are taken up with 20 60-watt lamps in holophane reflectors. Two large five-light fixtures surmount the posts of the big stairway, each containing five 40-watt lamps. The lighting under the mezzanine floor is taken care of by three 100-watt lamps in close ceiling fixtures and holophane reflectors.

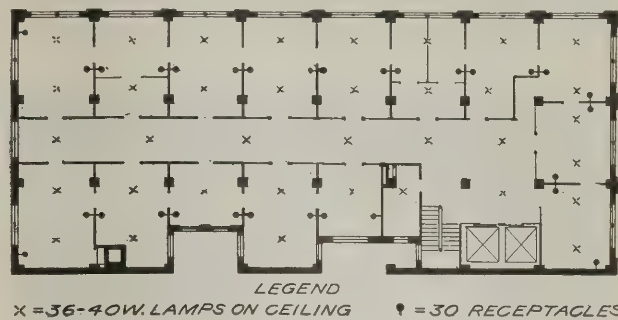


Fig. 4. Typical Office Floor Plan, Showing Arrangement of Lighting Units and Receptacles.

In the basement, which is somewhat larger than the main floor on account of extending under the sidewalks, the installation consists of 80 100-watt lamps in holophane reflectors placed ten feet above the working plane, and so distributed in single light fixtures as to give seven-foot candles on the working plane. Sixteen posts in the basement are equipped with 32 16-inch mechanically oscillated fans and 32 60-watt lamps in holophane reflectors the same as on the main floor. A panel on the main floor and one in the basement controls the operation of the store lighting.

On the roof of this building is located the largest electric sign southwest of St. Louis. The sign is a representation of a skyrocket, but contrary to the usual method of operation, viz., the rocket shooting up the face of the building and bursting on top, the rocket appears to start from somewhere behind the building, curves over the words "New Phoenix," and bursts at the cornice, showering stars down the side of the building and ending at the top of a large vertical sign reading "Clothing." The effect is shown in Fig. 2, taken on the opening night, and showing also a fireworks display on the roof. There are three shots of the rocket, the first bursting into red stars and showers, the second white and the last green. The flashing device is so arranged that there is one instant where all lamps are lighted, and six seconds when the entire sign is dark.

Fig. 5. Entrance End of New Phoenix Clothing Store, Showing Outside Lighting Units.

Fig. 6. Entrance End of New Phoenix Clothing Store, Showing Show Window Lighting.

The sign structure is 50 feet wide, 40 feet above the roof and 42 feet below the roof. The words "New Phoenix" are in five-foot letters and "Clothing" in 30-inch letters. The showers are 35 feet long and the vertical sign 28 feet long. The entire display is double face, containing 2,618 four candle-power Mazda 11-volt lamps, in addition to which there are approximately 1,500 color caps for the red and green effects.

Fig. 7. Side Show Windows of New Phoenix Clothing Store, Showing Lighting Effect.

An event was made of the first lighting of the sign. Following an hour's concert by the band there was a large display of fireworks from the roof of the building, as shown in Fig. 2, after which Mr. Jakowsky, the proprietor of the New Phoenix Clothing Company, pressed the switch which put the sign into operation.

The celebration was attended by a crowd of 6,000 people and voted a big success. The sign was designed and sold by the writer and built by the Greenwood Advertising Company. The lamps are General Electric Mazda, and the flasher from the Reynolds Dull Flasher Company.

A summary of the connected power and lighting load follows:

POWER LOAD OF THE BUILDING.

Two elevators, 20 hp	40 hp
Vacuum pump	2 hp
Water lift pump	2 hp
Ice water pump	1 hp
Sump pump	½ hp
Cash carrier	½ hp
Vacuum cleaner	3 hp
Total	49 hp

LIGHTING LOAD IN OFFICES.

There are seven floors alike, equipped with 36 40-watt and 30 receptacles.

Total of 252 40-watt	10,080 watts
Total of 210 receptacles at 50-watt	10,500 watts
Total	20,580 watts

LIGHTING AND FAN LOAD OF STORE.

88 100-watt lamps	8,800 watts
92 60-watt lamps	5,520 watts
5 40-watt lamps	200 watts
28 16-inch fans at 80 watts	2,240 watts
Total	16,760 watts

LIGHTING AND FAN LOAD OF BASEMENT.

80 100-watt	8,000 watts
32 60-watt	1,920 watts
32 16-inch fans	2,560 watts
Total	12,480 watts

SIGN LOAD.

2,618 5-watt lamps	13,090 watts
Combined total lighting and fan load	62,910 watts

Central station service of 220 volts three-phase 60 cycles for power and 220-110 volts, three-wire, 60 cycles for lighting is supplied from the mains of the Muskogee Gas & Electric Company. This company has been very successful in securing this class of business, its plant being responsible for the operation of all of Muskogee's large buildings and hotels, without exception. Their success along these lines is due to the maintenance of an energetic and capable new business department and a reputation for continuous and efficient electrical service.

Important Influences in the Making of Illuminating Engineering.

(*Contributed Exclusively to* Southern Electrician)

R. W. SHENTON.

As an art, illuminating engineering is a comparatively recent issue. While the history of artificial lighting dates back to obscure pages of history, not until recent years have the means and methods of lighting been developed to such an extent as to warrant specific attention to the art of illumination. The rapid strides made along developmental lines within the past two decades, and the extensive use of artificial light demanded by present-day strenuousness, however, call for close attention to the methods of installing illuminants and the illuminating engineer is today regarded as a needed specialist.

The strongest influence for better lighting conditions has been exerted by the manufacturers of lamps and lighting apparatus. The fundamental principles underlying light, its production and effects, which in earlier days were of importance only for their theoretical value in the work of the physicist, have been turned to practical advantage by lamp manufacturers in the perfection of their product. Just as the work of the physicist was supplemented by the lamp manufacturer so the efforts of the latter have also been furthered by the designers of reflectors and other accessories. The sum total of all these forces have resulted therefore in a stimulation of the art of illumination, the extent of which can hardly be estimated.

About a hundred years ago, the first electric light was exhibited in London by Sir Humphrey Davy, an English physicist. It consisted essentially of an electric arc produced between two wood-charcoal electrodes by a powerful

voltaic battery. The first important application of the arc lamp was not made until 1858 when, under the direction of Faraday, an installation was made in the South Foreland Lighthouse, England. This first installation was made possible by the invention of the dynamo-electric machine. Modified types of this arc, the open arc, are still being used for street lighting, the development in the nineteenth century having been confined chiefly to the perfecting of electrical generators.

About 1893, the enclosed arc was introduced and quickly met with favor. The flaming arc, using carbon electrodes impregnated with metallic salts, appeared commercially 12 or 14 years ago. A few years later, about 1904, the magnetite arc was made practical. The magnetite or luminous arc has a negative electrode of magnetite mixed with some titanium salts and a positive electrode of copper. In its present state of perfection, the arc lamp is an illuminant of acknowledged prowess in its particular field and has done much to improve lighting conditions by placing at the command of the illuminating engineer an illuminant of high candle-power.

Attempts to produce an incandescent electric lamp were made as early as 1840, although no practical lamps appeared until about 40 years later. These early lamps used platinum for their filament material. About 1880 the carbon lamp became a commercial possibility and this lamp soon became the popular illuminant paving the way for further improvements designed to revolutionize lighting methods.

Along in the early nineties, after the carbon filament lamp had come into wide use, reflector manufacturers saw the possibilties of improving illumination efficiency by the use of proper reflectors, and inaugurated a campaign with this end in view. The manufacturers of prismatic glassware were the pioneers in this work. Not satisfied with merely having their reflectors designed scientifically, these manufacturers directed their efforts towards having them installed in conformity with the principles of science. Accordingly, they distributed considerable literature to their customers and to all other persons likely to be interested in illumination, the gist of which was to point out the distinction between light and illumination and to show how good illumination might be obtained. This campaign, which has been continued to the present day, may well be considered the beginning of the art of illumination as we understand the term today.

The formation of the National Electric Lamp Association a few years later, added a fresh impetus to the movement for better illumination. The aims of this organization are to improve lamp quality and to better lighting conditions by co-operative efforts on the part of lamp manufacturers. Technical articles and bulletins varied in their nature so as to appeal to the scientist or the layman have been disseminated by this organization to all who are interested or engaged in the art of lighting. Some of the most valuable contributions to the library of the illuminating engineer have their origin in the engineering department of the lamp association. The illuminating engineers of this department have been doing much to promote good lighting by giving free consultation to all who care to avail themselves of this service.

Following upon the organization of the National Electric Lamp Association, came a succession of improvements in incandescent lamps. In 1905, the tantalum lamp made its appearance and for a short period was considered the acme of lighting achievement. Almost coincident with the advent of the tantalum lamp was that of the Gem, a metallized carbon filament lamp. These two lamps represented the first material advances in the manufacture of incandescent lamps since the time of their invention.

The tantalum lamp possesses several advantages over both the carbon and gem lamps, among them, higher efficiency, better quality of light, and symmetrical arrangement of its filament about a vertical axis. This latter fact is of material value in that it facilitates the design of reflectors to redirect light rays in definite directions.

Tungsten-filament lamps were offered for sale as early as 1906, but were not popularly used until a few years later. These lamps embraced all the good qualities of the tantalum lamp with the added advantages of very high efficiency, excellent color quality and longer life. The fragility of the earlier types, their only disadvantage, was soon overcome by the perfecton of the drawn-wire Mazda lamp, which appeared in 1911. This lamp is representative of the highest attainment on the part of manufacturers and has exerted a pronounced influence upon modern lighting methods.

A period of less than ten years has seen the efficiency of light production cut from 3.5 to 1 watt per candle, a gain in efficiency unparalleled in any other art. This was due primarily to the introduction of the modern Mazda lamp. The logical result of this wholesale development was to stimulate the use of electricity for lighting and to make imperative close attention to the methods of its use.

The high efficiency of the Mazda lamp made reflectors and shades more than ever a necessity from the point of view of comfort; while the desire for efficiency of illumination commensurate with the efficiency of light production spurred all reflector manufacturers toward scientific development of their products. Reflectors were designed to give various types of distribution and curves to show the distribution were published by all progressive manufacturers, a fact which at once put this branch of the industry upon a scientific basis. By referring to such curves the illuminating engineer can choose the reflector that will best answer his requirements.

By virtue of the regular arrangement of the filamest of the Mazda lamp, the design of reflectors both symmetrical and asymmetrical was greatly facilitated. While the earlier types of prismatic reflectors were effective in a great many classes of work, it was not long before various forms of efficient artistic reflectors were available. To meet the requirements of industrial lighting, high-efficiency steel reflectors were designed. The tendency of these improvements in reflecting accessories was to do away with unsightly installations of drop-cord, spot-lighting, units of the tin-shade variety and to supplant them by modern lamps in efficient reflectors that give uniform general illumination or pleasing localized lighting, as the case may have required. These new systems operate at a cost considerably below that of the inefficient systems displaced and in this regard the Mazda lamp must be given a share of the credit for these signal advances.

While as above suggested, the manufacturers of electric lamps and reflectors deserve considerable credit, they have not been alone in the work of development. The gas interests have been well in the foreground and by continued improvements in their lamps have done much for the cause of illuminating engineers in spite of the disadvantages that attend the use of gas for lighting.

While the various manufacturers were carrying on mis-

sionary work along their respective lines, a project was on foot to bring together these several forces into one united movement in the interest of illumination. In December 1905, Mr. L. B. Marks, Mr. E. L. Elliott and Mr. V. Lansingh sent a circular letter to a number of men known to be interested in the subject of illumination, suggesting a meeting in New York City to discuss the formation of a society to foster the interests of the science and art of illumination. Twenty-five men attended this meeting, which marked the birth of the Illuminating Engineering Society. In the discussion, it was generally agreed that in matters pertaining to illumination there had been a lack of co-operation among the electrical engineers, the gas engineers, the architects and designers of fixtures; and that the dictates of science and the requirements of art were too often at variance. The new society proposed to remedy this condition. While the organization aimed chiefly to promote the art of illuminating engineering, it resulted in the first recognition of illuminating engineering as a distinct profession.

Critics were not sanguine as to the future of the society and expressed little confidence in the establishment of illuminating engineering as a separate art. They were rather inclined to consider the work planned as part of the regular functions of the gas or the electrical engineer. The organization experienced a remarkable growth, however, and doubters were soon convinced not only of the feasibility of the project but of its actual necessity. The membership in 1906 was less than one hundred; today the members number about fifteen hundred.

The Illuminating Engineering Society has done much to advance the art. The presentation and discussion of papers on the various commercial illuminants have aided the engineer in forming unbaised opinions as to their relative merits. These discussions have often led to questions not directly related to the manufacture of illuminants but which are of great importance to the illuminating engineer. A study of the physiological and psychological effects of light have better equipped him to provide for the humanitarian element in illumination design.

Today, the importance of the illuminating engineer is recognized. The remarkable saving that is occasioned by installing efficient lighting systems is a convincing testimonial of his work. The attractiveness and comfort of such systems are pleasing evidences of the results obtainable through the art of scientific illumination, and high standing of illuminating engineering among the useful arts is due jointly to the active interest of those engaged in its pursuit and the untiring efforts of the manufacturers who created and stimulated this interest by providing illuminants adequate to modern needs.

The Cost of Light and a Comparison of Lighting Units.

(*Contributed Exclusively to* Southern Electrician)

BY A. G. RAKESTRAW.

THE items entering into the cost of light are as follows: 1. The cost of the current, gas, oil or other basic material. 2. Cost of the renewable elements, such as incandescent lamps, carbons, vapor tubes, mantles, etc. 3. Repairs to the system. 4. Depreciation. 5. Interest on the investment. In this article four sets of curves are presented showing the total cost of producing light per 1000 spherical candle-power hours with varying cost of current per kilowatt-hour. In studying these curves, the reader should bear in mind that the lighting cost as shown is not necessarily a measure of the net lighting efficiency, inasmuch as other considerations often outweigh the question of the cost as indicated. However, other things being equal, the source that can produce the greatest amount of light flux at the least expense is, of course, the most desirable.

The accompanying table gives the data used in making these curves and show the principal types of lamps in common use with their candle-power, current and voltage ratings given under average conditions and with the types of globes, reflectors, etc., in general use. This data has been secured from a number of different sources and does not profess to be strictly accurate for the product of any one manufacturer, but represents the best average practice for the type of lamp given. This data will be found of most value simply as an illustration of the general principles involved and as presenting the results which we may be fairly certain to find in practice.

In the curves of Fig. 1, the various filament lamps are compared, and it will take but a glance to show that at all but the very lowest current costs, the Tungsten lamp is so far superior to all the others that it is only in those limited cases involving rough handling or very small units, that the carbon filament will be used, in fact, it is only the short-sightedness of many customers, aided by the practice of lighting companies to furnish free renewals, that accounts for the large numbers of the carbon filament lamps yet being used. These curves also show the advantage in using the larger sizes of Tungsten lamps wherever possible.

Table. I. Showing Characteristics of Most Common Lighting Units.

Kind of Lamp	Sph. C. P.	Amp	Volts	Watts	W.P.C.	Cost* 1000 hrs	Cents per c.p.
25-W Tungsten ..	15.6	.23	110	25	1.6	0.62	4.0
250-W Tungsten..	172	2.3	110	250	1.45	3.02	1.75
G E M- 20 c. p....	16.5	.45	110	50	3.05	.44	2.7
A. C. Enc. Arc....	225	7.5	110	540	2.4	1.50	.67
D. C. Enc. Arc...	320	6.5	110	715	2.2	1.50	.47
4-A. Magnetite ..	285	4	78	310	1.12	2.70	.95
6.6A. Magnetite..	720	6.6	78	510	.71	3.54	.5
D. C. Flame Arc..	1100	10	55	550	.50	17.50	1.6
Mercury Vapor							
C-H Type H H..	700	3.5	110	385	.55	7.10	1.0
Quartz Tube	2600	3.5	220	770	.30	10.70	.4

*Including Current, Renewals, Interest, Repairs and Depreciation. All lamps taken in most popular types and sizes with equipment in common use.

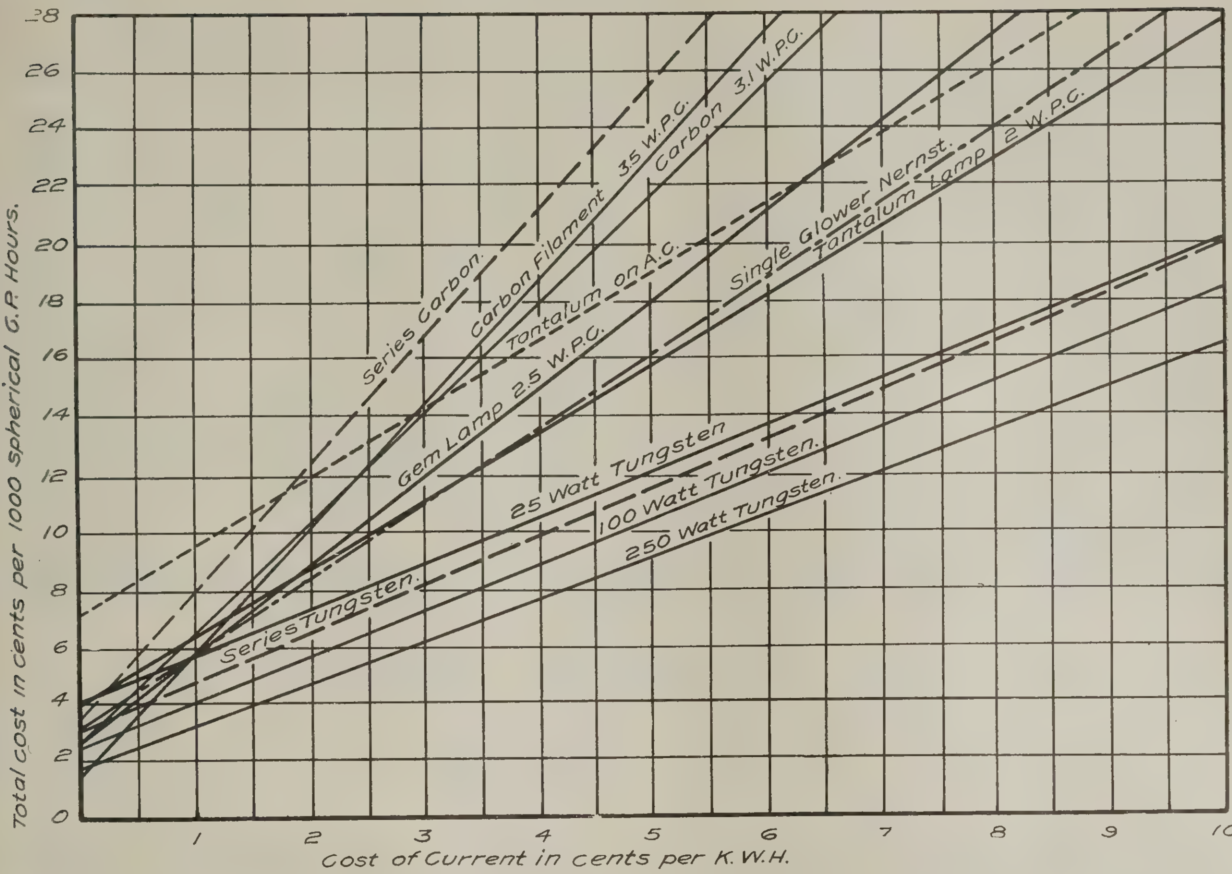


FIG. 1. COMPARISON OF FILAMENT LAMPS.

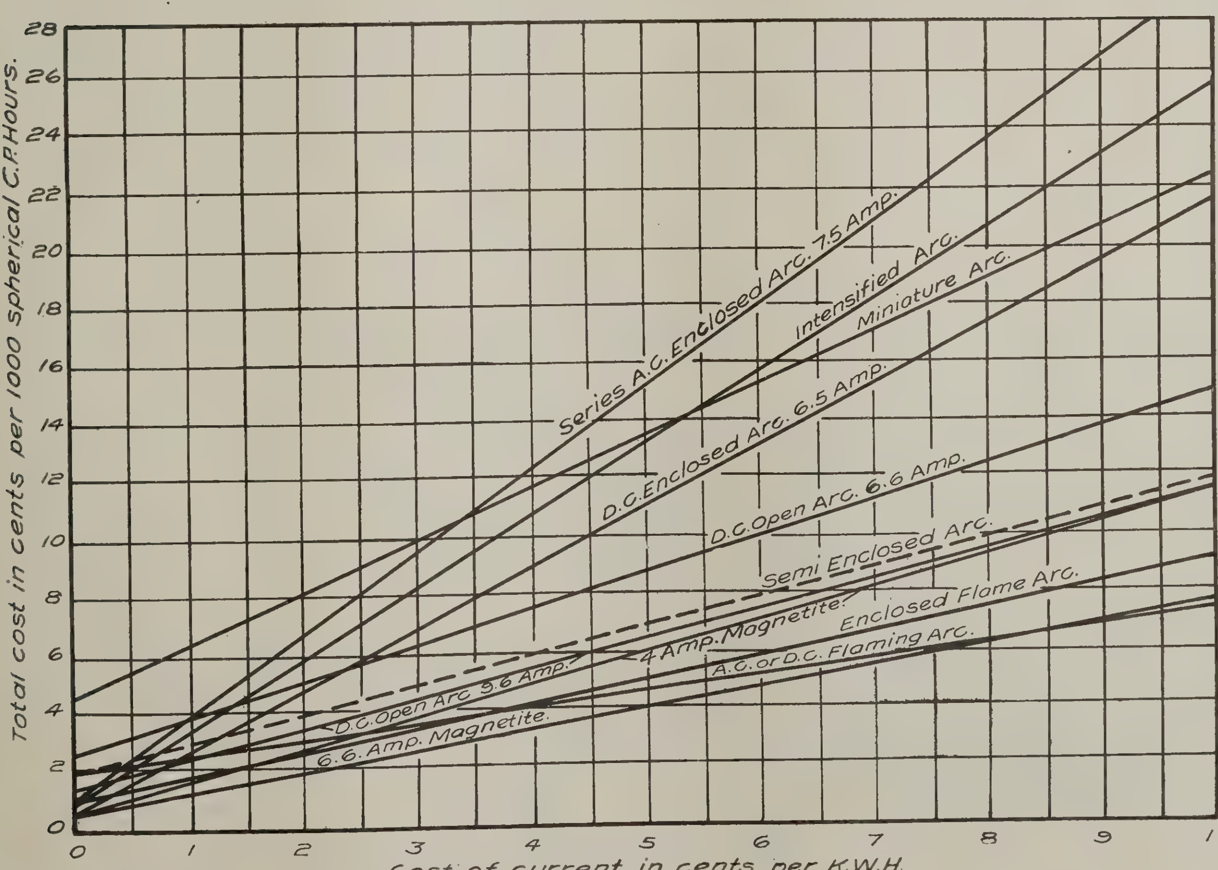


FIG. 2. COMPARISON OF ARC LAMPS.

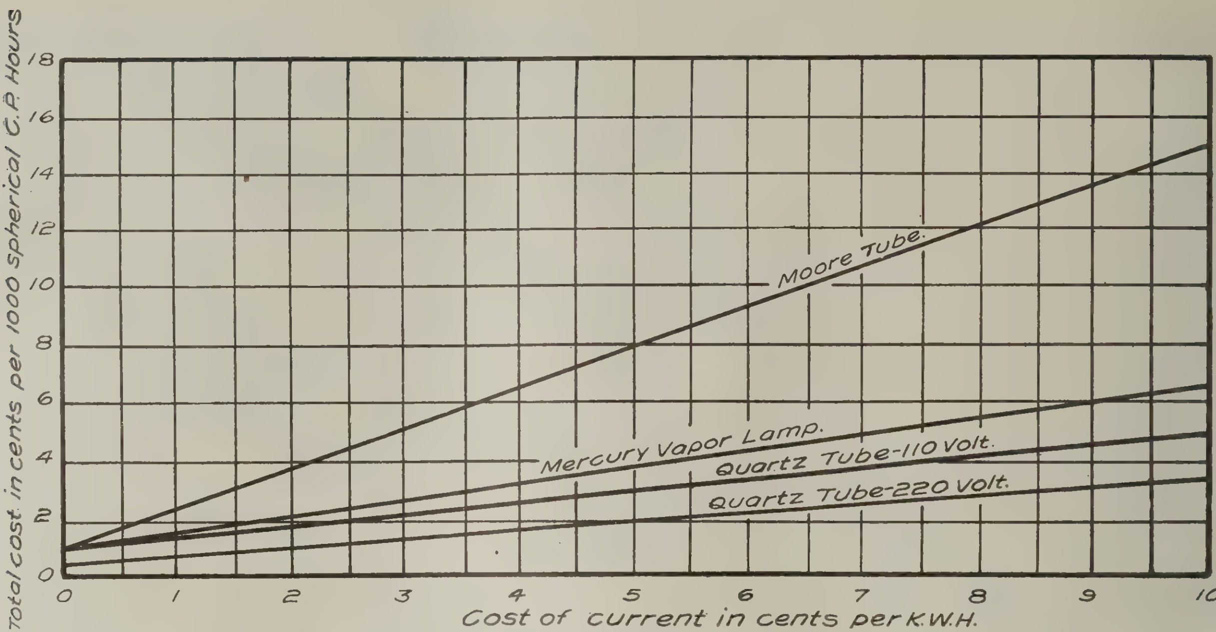


Fig. 3. Comparison of Vapor Lamps.

In Fig. 2 a similiar comparison of the arc lamps is presented. It is just as readily seen from this set of curves that the flaming arc (including the so-called luminous arc or magnetic lamp) has about as great an advantage over the carbon arc heretofore in use, as the tungsten has over the other filament lamps. The old open arc is practically obsolete, and the miniature and semi-enclosed lamps which were used to some extent for interior lighting prior to the introduction of the tungsten lamp are also practically out of use, and in the opinion of many practical illuminating engineers the carbon enclosed arc will soon have to follow them.

The set of curves in Fig. 3 show a comparison of the vapor lamps. Of these the Moore tube, while used in a number of places in New York City, is not as yet considered as a general illuminant. We see from this sheet the remarkable results secured by the mercury vapor or Copper-Hewitt lamp and by the Quartz lamp which differs only in using a quartz type instead of glass. The Quartz lamp is a recent introduction and the figures given are approximate, but so far it seems to be about the last word as regards efficiency.

In the set of curves of Fig. 3, are given the principal curves from the three preceding sheets together, with some

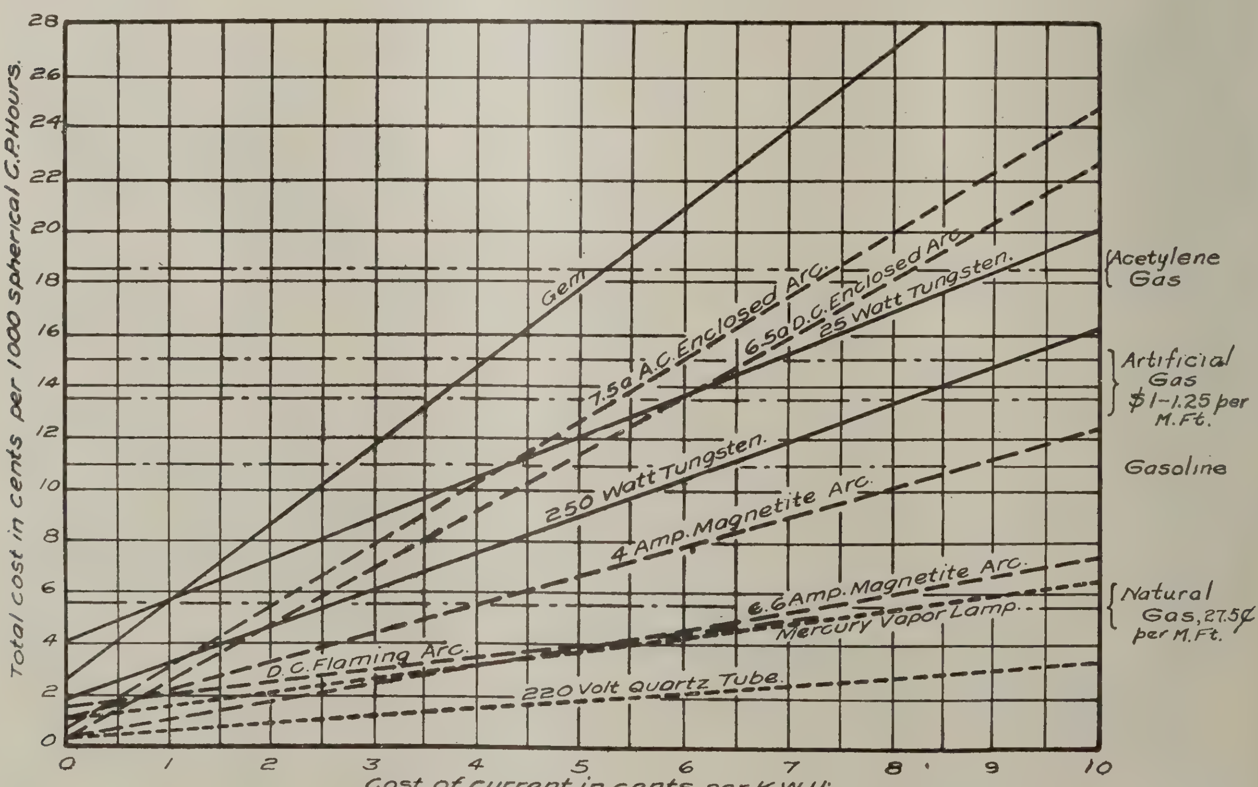


Fig. 4. Comparison of Most Common Units.

curves for gas lighting. We note that the tungsten lamp in the larger sizes is more efficient than any of the carbon arc lamps at two cents per kw-h or over. We also note the practically identical cost of the mercury vapor lamp, the flaming arc lamp and the magnetic lamp. This indicates a very close competition between the mercury vapor lamp and the flamer for industrial work where large units are used, and we find this to be actually the case. We would also expect some competition between the flamer and the magnetite lamp for street lighting, but the trimming expense being lower for the illuminous arc gives it quite an advantage at low current costs, and we therefore expect to find the flamer used only for general street illumination in business sections where the expense is justified, and this again we find to be the case.

In short, after analyzing the conditions it is found that the whole number of illuminants narrows down to about three, the tungsten, the flamer (including the magnetite), and the mercury vapor lamp, (including the quartz lamp).

There are a few curves given to show the comparative cost of electric light and gas. Since this cost bears no relation to the price of electricity, these curves are horizontal lines. Natural gas using mantles is an undeniably cheap light source, not even approached by the tungsten lamp at any rate for current likely to be given for residences. Artificial gas on the other hand, should not be a serious competitor of electricity since the cost is not greatly below that of the tungsten lamp when equipped with efficient reflectors. Acetylene and gasoline gas need hardly be considered as competitors of the central station, as the nature of these systems has practically limited their use to territory where electricity is not obtainable.

The Equipment and Engineering Essential to Proper Industrial Lighting.

(*Contributed Exclusively to* Southern Electrician)

THOMAS W. ROLPH, DESIGNING ENGINEER.
NELITE WORKS OF GENERAL ELECTRIC CO.

A Discussion on Design and Use of Reflectors in What May Be Termed New Industrial Lighting.

THE mills and factories of the country are awakening to the need of better lighting, and specialists in illumination are showing the owners and managers that it is possible and profitable. The lamp manufacturers have given them a lamp three times as efficient as the old carbon filament type, and the reflector manufacturers have brought out a great variety of efficient reflectors especially adapted to industrial needs with this variety being constantly added to as special problems develop the need of special reflectors. The movement for good lighting therefore is spreading with great rapidity, and rightly so, for it means increased profit for the manufacturer and greater comfort and health for his employee.

The industrial lighting of today and what may be called the "new industrial lighting" is based on fundamental engineering principles. It aims to give the factory or mill correct illumination in every part of the establishment at a low cost of operation and with the maximum protection to the eyes of the workers. The result is an increased efficiency of operation, a greater output with the same working force, less spoilage, fewer accidents and a greater satisfaction among employees.

In this new industrial lighting the reflector is playing the master part, for the reflector is the means of obtaining an efficiency of illumination impossible with the bare lamp. It serves to give the light its proper directional value and protects the eyes of the workers from the glare of the brilliant filament, when such protection is necessary. A mere glance at the photometric curve of a bare lamp and a lamp and reflector is sufficient to give some idea of the importance of reflectors in obtaining illumination efficiency. Fig. 1 shows such a comparison.

It may be well to explain here the meaning of the photometric curve which is sometimes misunderstood. It represents candle-power or intensity of light only, in various directions in a vertical plane passing through the light source. With symmetrical reflectors this is usually the average vertical plane, as the reflector will give approximately the same candle-power in all directions which are at the same angle from the vertically downward direction.

The reflector gives a great increase in the candle-power of the light in useful directions. Of course, the light which goes upward with the bare lamp is not always entirely lost, but even with pure white ceilings and pure white walls over 50 per cent is absorbed and does not reach the lower part of

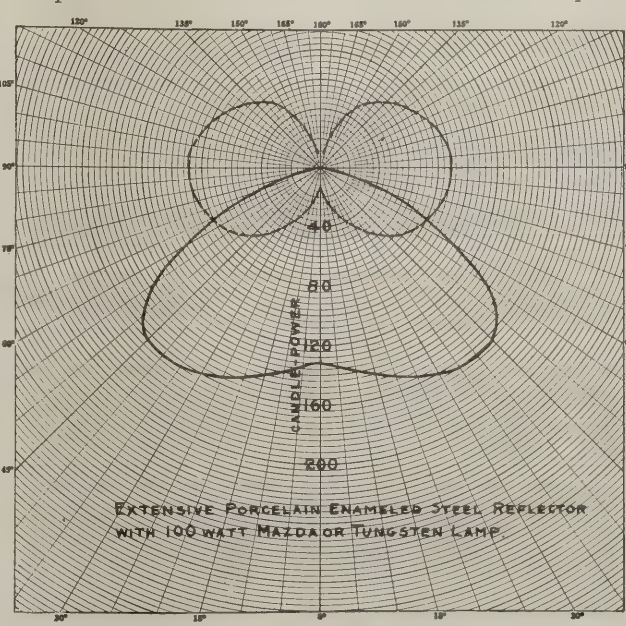


Fig. 1. Photometric Curve of Bare Lamp and Lamp With Deep Porcelain Enameled Steel Reflector.

the room. When walls and ceilings are dark in color, the loss is much greater, and with conditions often met in factories, the light emitted above the horizontal is practically all lost. Illumination tests have been made in a medium size room using bare lamps, and lamps equipped with deep metal reflectors having aluminum interior finish. These tests were made under various conditions of ceiling and walls. With white ceiling and white walls the use of reflectors increased the illumination 17 per cent over that obtained with the bare lamp; with white ceiling and black walls, the increase was 31 per cent and with black ceiling and walls it was 110 per cent. The figures with white porcelain enameled reflectors would be practically the same.

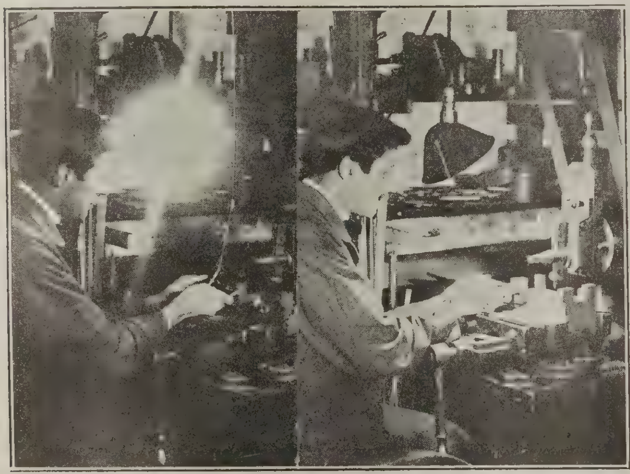


FIG. 2. MACHINE LIGHTED WITH BARE LAMP AND BY LAMP WITH REFLECTOR.

Fig. 2 tells the story of the importance of the reflector in giving light in proper directional value and also in protecting the eyes of the worker.

CLASSES OF REFLECTORS.

The reflectors available for industrial lighting are of two general classes, glass and metal, the former translucent and the latter opaque. Metal reflectors are the more widely used. The glass reflectors which are used largely are of the prismatic type. These are available in all sizes and with distributions of light varying from the extensive, which spreads the light over a wide area, to the concentrating which throws the light downward on a small spot beneath the reflector. Glass reflectors are not used in places where dirt accumulates rapidly unless a thorough system of maintenance is observed, insuring the cleaning of the reflectors at frequent and regular intervals. Glass is sometimes advocated on the score of greater appearance of cheerfulness in the room, since the upper part is not left in darkness. With light ceilings there is little to choose between the two on the efficiency basis. With dark ceilings, metal reflectors are, in general, more efficient.

METAL REFLECTORS WITH ALUMINUM VS. PORCELAIN FINISH.

The great majority of metal reflectors are of steel with an applied finish of aluminum or white porcelain enamel. It is profitable to compare the characteristics of these two finishes as each has its particular sphere of usefulness. The character of the light reflected from a single point of the surface is quite different in the two cases. Fig. 3 illustrates this difference. The aluminum finish gives what is known as spread reflection. The greatest intensity of reflected light is at the same angle as the incident light, thus following the law of regular reflection. The slightly roughened surface gives a spreading action, however, and the reflected light is spread through a small angle on either side of the maximum ray. The surface of porcelain enamel, on the other hand, is very smooth, but nearly all of the reflection is from minute particles beneath the surface. The aggregate effect of these particles is to give perfectly diffused reflection, the photometric curve of which is a circle tangent to the surface. The maximum intensity is perpendicular to the surface, regardless of the angle of the incident light. In addition, however, a small portion of the light is reflected from the surface itself and not from the particles beneath. This light follows the law of regular reflection and adds to the light reflected at the same angle as the angle of incidence. The comparative efficiency of the two surfaces depends on the shape of the reflector.

With deep reflectors, an enamel surface reflects more light back into the reflector than an aluminum surface and consequently there are more second and third reflections of light rays. This gives a higher absorption and lower efficiency in the case of enamel. With shallow types of reflectors, this advantage of aluminum disappears and enamel is the more efficient finish. Aluminum finish lends itself readily to the design of reflectors to give predetermined photometric results. By properly designing the shape of the reflector almost any desired distribution of light can be obtained from an aluminum finish. With enamel, the variety of distributions obtainable is more limited. Enamel must be given the credit of having a surface considerably easier to clean than aluminum. The former is a perfectly smooth surface while the latter is somewhat rough. There is usually on that account a greater depreciation due to dust in the case of installations of aluminum finished reflectors. In fact, aluminum even after being thoroughly washed, will never in actual practice show the same efficiency which is initially obtained. On account of the cleaning advantages of enamel, it is to be preferred except for

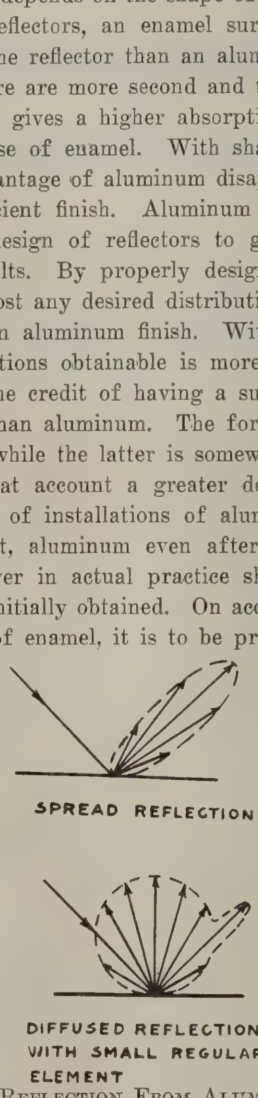


FIG. 3. SPREAD REFLECTION FROM ALUMINUM FINISH AND DIFFUSED FROM PORCELAIN ENAMEL FINISH.

installations where the desired distribution of light cannot be obtained with an enamel reflector or installations where an excellent system of maintenance is observed. It is a significant fact that in the class of shallow reflectors where enamel is the more efficient surface, no aluminum finished reflectors are on the market; yet in the class of deep reflectors where aluminum is the more efficient surface, a variety of enameled reflectors are available and widely used.

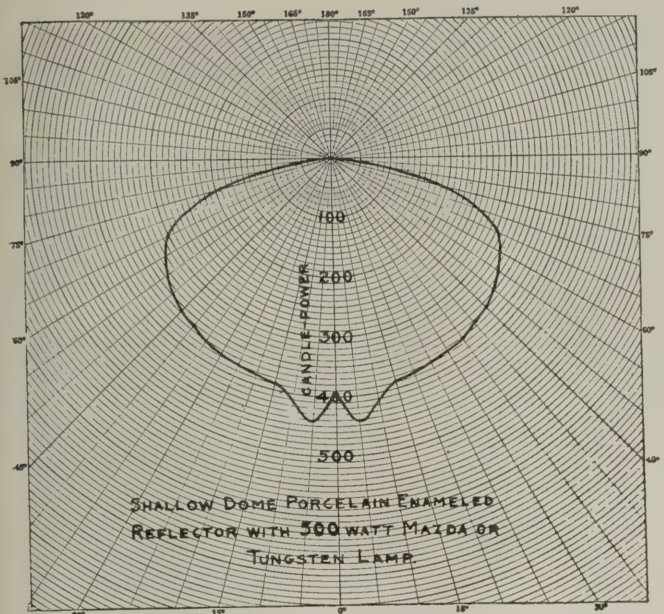


FIG. 4. PHOTOMETRIC CURVE OF SHALLOW DOME PORCELAIN ENAMELED REFLECTOR.

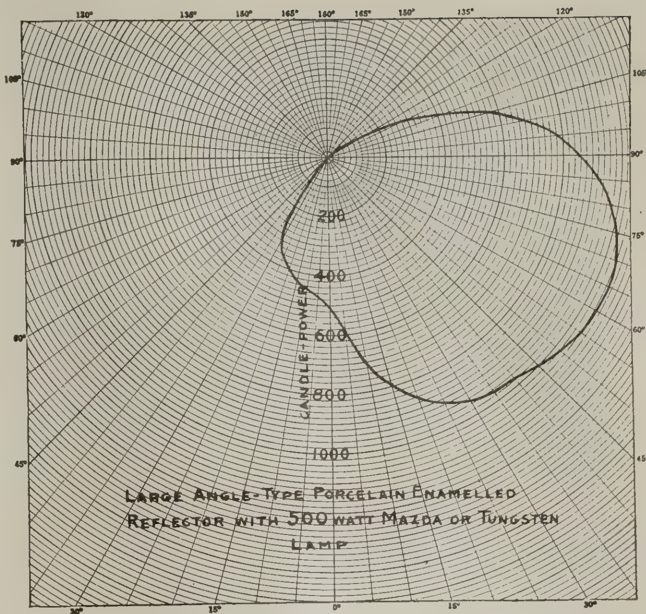


FIG. 5. PHOTOMETRIC CURVE OF PORCELAIN ENAMELED ANGLE REFLECTOR.

CHOICE BETWEEN DEEP AND SHALLOW REFLECTORS.

Distinction should be made between shallow reflectors and flat reflectors. While both have a large diameter compared with their depth, the shallow reflectors cover the lamp to a considerably greater extent, the lower edge being usually approximately on a level with the bottom of the filament. Flat reflectors give lower illumination efficiency and less eye protection. Shallow reflectors are always preferable.

FIG. 6. HOLDING DEVICES FOR STEEL REFLECTORS. A—CLIP SPRING; B—STANDARD HEEL; C—FOR PORCELAIN SOCKET; R—WITH SOCKET ENCLOSED IN EXTENSION; S—SAME AS R WITH SCREW THREAD.

The deep reflector is much narrower and somewhat deeper than the shallow reflector for the same size lamp. The lower edge is considerably below the bottom of the filament. The choice between deep reflectors and shallow reflectors should be determined by the character of illumination desired. Deep reflectors afford a greater protection to the eyes. Shallow reflectors, on the other hand, throw more light sideways and are useful in obtaining illumination on vertical and oblique surfaces and in lighting the upper parts of large machines, overhead belting, etc. Fig. 1 is the photometric curve of a typical deep reflector, while Fig. 4 shows the curve of a shallow reflector. The total output of shallow reflectors is greater than that of deep reflectors, that is, shallow reflectors give a greater quantity of light with the same lamp, although not necessarily a higher intensity of illumination, as that depends on the conditions of installation. This higher total efficiency is due partly to the shape of the reflector and partly to the fact that the lamp is not shaded so much and a lesser quantity of the light strikes the reflector. In general it may be stated that where illumination on a horizontal plane is desired, deep reflectors are to be preferred on account of the greater eye protection afforded. Where illumination is desired on vertical and oblique surfaces, or where overhead belting or machinery must be lighted, shallow reflectors should be considered. A study of the details of each problem will determine the type to use.

ANGLE REFLECTORS.

There is another class of reflectors which has a wide field of application particularly for the local lighting of a machine or small portion of the work. These are the angle reflectors. They are made to give a large variety of distributions, the variety being greatest in the smaller sizes which are widely used for local lighting with 25 and 40-watt tungsten filament lamps. Recently large size angle reflectors available for lamps up to 500 watts have been put

out. Fig. 5 is the typical curve of these large reflectors. It finds a particular field of usefulness in lighting large shops from the side when a traveling crane prevents the use of lights overhead.

HOLDING DEVICES FOR METAL SHADES.

The past year has seen the development of several new types of holding devices for metal reflectors. Fig. 6 illustrates a number of those in most common use. A is the clip spring holder, typical of a variety of holders which can be attached directly to a brass shell socket. B is the standard heel type. These are made to fit standard 2¼-inch and 3¼-inch holders in the same manner as glass reflectors. C is a holder especially designed to fit porcelain sockets. R shows a holding device which includes the socket permanently held within as part of the reflector. This light unit is installed by simply wiring and attaching to half-inch pipe. S is the same holder with an added feature which makes it easy to detach the reflector for cleaning. The holder and reflector are separable and held together by a screw thread, so that to remove the reflector it is only necessary to unscrew it.

To treat fully of the proper use of reflectors in industrial lighting would be beyond the scope of this article. Only a few points can be briefly touched here. Illumination is general or local, depends on whether a space is lighted as a whole or whether some portion or object receives particular treatment. Any space may have both classes of illumination, and it often happens that a low general illumination is supplied and supplemented by local lighting at the working points. A third term, "group lighting," is used to refer to the lighting of a group of objects or machines by a single light or row of lights without reference to the room as a whole.

THE DESIGN OF LIGHTING SYSTEMS.

Lighting systems for general illumination are usually designed on the basis of the illumination desired on a horizontal plane. Such a lighting problem divides itself naturally into two parts. First, to determine the wattage necessary, and, second, to determine the best size and distribution of the light units. The wattage necessary is usually found by the following formula: Watts=(area × foot-candles)÷constant. The foot-candles or intensity of illumination desirable depends upon the character of work to be performed. For most work on light-colored goods three foot-candles is ample. For detailed work on dark goods, ten foot-candles is none too much. Data is available, giving the intensity most suitable for each class of work. The constant depends on the kind of lamp and the kind of reflector, and the constants of most of the reflectors in common use can be obtained from the manufacturer. Having determined the wattage necessary, this wattage should be divided among the lamps in such a way as to illuminate the space with approximate uniformity. This is usually a cut and try process. The space is divided into squares or rectangles as nearly square as the construction of the room will permit, and one lamp or cluster is placed in the center of each. The size of the squares varies from eight feet to 20 feet or more. Squares as small as eight feet are necessary only in rooms with low ceilings where close work is performed. The smaller the square the less troublesome will be the shadows on the work and the glare which is caused by regular reflection from smooth surfaces worked on. Dividing the total wattage by the number of squares gives the wattage at each outlet. If this comes out an unreasonable or impractical quantity another size of square must be tried until a good solution is obtained.

To determine the height at which to place the reflectors, use is made of the spacing constant or k—value of the reflector, where,

k = (average distance between outlets)÷(height above plane of illumination).

For every photometric curve there is a minimum value of k, at which uniform illumination will be most efficiently obtained. For every value of k there is a minimum or most

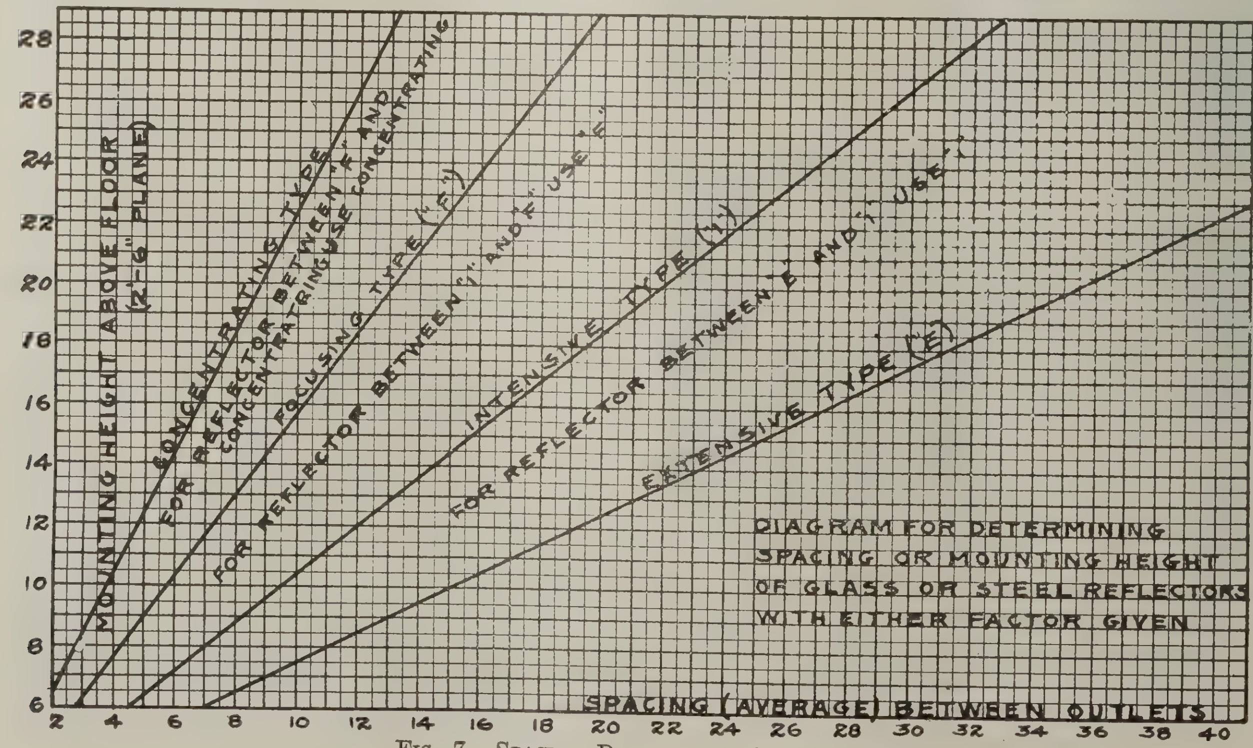


Fig. 7. Spacing Diagram for Reflectors.

concentrating photometric curve which will most efficiently obtain a given uniform illumination at that spacing. Reflectors which are to be used for general illumination should be designed to give as nearly as possible the minimum curve for the value desired. The reflector whose curve is shown in Fig. 1 is so designed. This is an extensive curve and the value of k is approximately 2. Reflectors having larger k values are not ordinarily used in industrial lighting. The tensive reflectors have a k value of 1¼, while still more concentrating reflector can be obtained with a value of ⅔. The k value determines the best height at which to place the flector to use when the height must fall within certain limits. Ordinarily the reflector having the smallest k-value which the ceiling height will permit, should be selected. A spacing diagram will often assist in determining the type of reflector and the height. Figure 7 shows such a diagram based on the assumption that the illumination is desired on a horizontal plane 2½ feet above the floor.

When illumination is desired on vertical or inclined surfaces the calculations for horizontal illumination are not always satisfactory. Sometimes it is desirable to use reflectors having a larger k-value than the spacing and height call for, thus obtaining more light sideways. The distributing type reflectors, a typical curve of which is shown in Fig. 5, is often valuable for meeting these requirements. This curve has a k-value of approximately 1⅓, but it is not the minimum curve for this value. Consequently this reflector throws more light sideways than reflectors designed particularly for horizontal illumination. The distributing type of curve can be used at wider spacings than its k value calls for with better results than a curve designed particularly for that value of k. This is because the sideways light from these reflectors insures a comparatively high illumination half way between outlets even at wide spacings. On that account this type of reflector is often used where wide spacings are necessary.

The problem of local lighting consists largely of treating each proposition individually according to the plan which practice or common sense dictates as best. In fact common sense will satisfactorily solve most of the problems of local lighting. It requires no expert to place a reflector over a machine in such a position as to obtain "light on the object and not in the eye." The man who encounters such problems should become familiar with the reflectors available, however. There are, of course, many local lighting propositions for which the treatment has been standardized as that which practice has shown to be best. These cannot be taken up in detail here.

Group lighting offers much the same problem as local lighting, and should be treated on the same basis. Where more than one light is used, the k-value of the reflectors should be considered, however. When one light only is used the distribution of light from the reflector should be carefully considered with regard to the area to be illuminated and the height at which the reflector is placed.

The treatment of the subject here can do nothing more than indicate a few important considerations. The designer of lighting systems for factories should have at hand more detailed data regarding the methods employed. He should also have detailed information regarding reflectors and lamps, including photometric curves, illumination constants and spacing constants. All of these can be obtained from the reflector manufacturers, who have adopted a progressive attitude and are now supplying complete performance data regarding their product.

The Proper Choice of Lamps for Central Station.

BY R. E. CAMPBELL AND M. D. COOPER.

It is now generally recognized by central station men that the greatest financial return from the lighting field depends in a large degree upon the promotion of the incandescent lamp in such a way that an economical and satisfactory light is furnished all customers. This means that every circuit of a distribution system must operate the lamps best suited to both electrical conditions and illumination requirements.

In a paper by the above authors at the Seattle convention of the N. E. L. A. the proper lamp for a circuit was defined as such a lamp as would produce the desired intensity of illumination, the proper quality of light, the minimum fluctuation of intensity and the maximum economy. The two latter items were mainly discussed in that paper treating so many interesting phases of plant operation, transmission of energy and translation of energy into light, that we present an abstract here under these three heads.

CONDITIONS SURROUNDING PLANT OPERATION.

In considering the effect of plant operation on the voltage, the first element is naturally the prime mover. The steam turbine, reciprocating engine, water turbine and gas engine are all designed to give fairly constant speed over a considerable range of load. The low speed reciprocating engine belted to a high speed generator is very likely to produce a cyclic fluctuation in voltage. No criterion for the amount of this fluctuation can be given, however, since it depends to a large extent upon the speed and size of the flywheel.

The second element to be considered is the generator. The effect of power factor on the increase in size of generator need not be discussed since it does not affect the voltage at the terminals of the machine as long as the exciter is of sufficient capacity to supply the additional field current required. The tendency in the design of alternators, at the present time, is to neglect inherent voltage regulation since much closer regulation can be secured by the use of more easily controlled auxiliary apparatus.

The next element to be considered is the switch-board and the necessary measuring instruments. Of the instru-

ments on the switch-board, the one in which we are principally interested is the voltmeter. This instrument might properly be termed the "pulse" of the central station. By means of the voltmeter the station attendant is enabled to judge the condition and quality of service which is being rendered. A voltmeter which reads high causes a loss in revenue due to decreased wattage. It will also cause more complaints on service than one reading low, due to the fact that the lamps on the circuits are burning at a lower candle-power and a lower efficiency than that at which they are intended to burn.

The last element in station operation to be considered is such apaparatus as balancer sets and constant-current transformers. Due to the fact that direct current finds its greatest application in the business districts of large cities where especial care is taken to secure proper balance, very little need be said concerning the balancer set.

The following is an interesting method of regulating a three-wire circuit, which fulfills the required conditions. This scheme prescribes the use of 220-volt generator and a balancer set—one automatic regulator being placed across the 220-volt busses and another regulator across one side of the balancer set whose field coils are cross-connected. This method would find special application where an intermittent heavy load cannot be divided between both sides of the line.

Another form of auxiliary apparatus which has an effect on voltage regulation is the machinery used in supplying constant-current circuits. The principal trouble would be encountered when only one of these regulators is used on a three-phase circuit. Their power factor is so low that they cause considerable inductive drop on the one phase, thus distorting the normal condition of balance.

CONDITIONS SURROUNDING THE TRANSMISSION OF ENERGY.

The transmission of energy from the central station to the lamp socket is a very important step to be considered in placing the proper lamp on the circuit. It is in this step that the greatest voltage losses occur. The usual designs of feeder systems aim to take care of the voltage drop within two per cent. It is realized, however, that in a commercial installation which must supply various classes of load, this condition is seldom attained. As sometimes happens in small cities, the feeders which supply the business section also supply some of the residence section. It is obvious that the maintenance of a uniform voltage over the entire system—where the peaks of the business lighting and residence lighting loads do not coincide—would be practically an impossibility without suitable feeder regulators, regardless of the uniformity of the station voltage. Automatic feeder regulators are made in a number of forms as are also hand and motor-operated regulators. The use of a regulator will often reduce the total expense necessary to maintain proper voltage regulation. This, of course, depends almost entirely upon the amount of load and distance of transmission. Only the largest central stations as a rule have feeder regulators installed.

On three-phase distributing systems it is found that in many of the smaller cities where the power load is almost all concentrated down town, the three phases are led to a center of distribution. From this center the three-phase power circuits are distributed and single-phase lighting circuits are taken off to various parts of the town. This works out very well as long as the power load and the lighting load do not overlap. At certain seasons of the year, however, they do overlap to a considerable extent and the low power factor incident to the use of lightly loaded motors introduces a considerable primary drop, which would not otherwise occur.

At this point it may be well to give a summary of the transmission systems in general use. The following classification in Table I of the 82 plants, shows the fact that the three-phase, 2,200-volt distribution system has found considerable favor among central station managers.

TABLE I. DISTRIBUTION SYSTEMS IN USE.

A. C.	2200 V.	1100 V.	220 V.	110 V.
Three-phase	33	6	..	..
Two-phase	10	4	..	..
Single-phase	10	10	..	..
D. C.				
Three-wire	..	..	6	..
Two-wire	..	..	4	4

The transformer is another important consideration in supplying energy to the lamp at its rated voltage. It has been found that unless especial attention is given to the loading of transformers there is a tendency to overload them. This is in a large measure due to the rapid growth of the electric industry. Customers are being continually added to the transformers already in service with the result that they soon become considerably overloaded. In selecting transformers for lighting loads, the regulation from no load to full load is a very essential point to consider. This is because the drop in a transformer is in addition to that in the feeder and the variations in generator voltage. Even when the drop in the generator and feeder is compensated for at the switch-board, by hand or automatic regulation, it is impossible to keep the voltage at a uniform value all over the lines due to the different loading conditions on each transformer.

The effect of low power factor on the regulation of a transformer is to increase still further the voltage drop. An 80 per cent power factor will cause a drop from 4 to 5 per cent at full load. Added to this transformer drop is the secondary line loss and the loss in the customer's premises between the service switch and the lamp socket.

Under average conditions the secondary voltage drop should not amount to more than two per cent. However, the average secondard drop is from 4 to 5 per cent. This indicates the fact that the secondary lines are, in the majority of cases, overloaded. Such a voltage loss still further decreases the value of the service to the customer and the available revenue to the central station. In addition to the secondary drop, there is a voltage drop on the customer's premises, between the service switch and the lamp socket. The average maximum drop in this case is found to be about two per cent.

EFFECT OF VOLTAGE LOSS ON REVENUE.

The large majority of incandescent lamps are intended for operation on constant-potential circuits. Therefore, a lamp gives its rated candle-power and watts only when operated on a circuit of a voltage equal to the rated voltage of the lamp. If the circuit voltage is less than the rated lamp voltage, the candle-power and watts are decreased. If the circuit voltage is greater than the rated lamp voltage, the candle-power and watts are increased. The curves shown

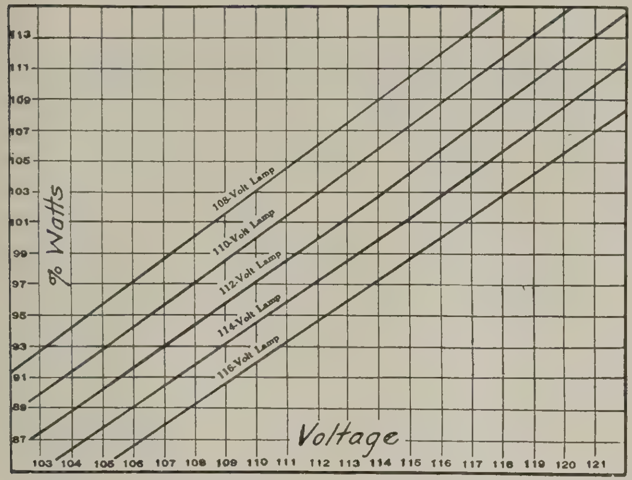


FIG. 1. PER CENT WATTS FOR VARIOUS VOLTAGES WITH TUNGSTEN LAMPS.

in Figures 1 and 2 give the per cent watts and per cent candle-power which will be obtained at various voltages from tungsten-filament lamps rated at 108, 110, 112, 114 and 116 volts.

Some very striking figures can be given as to the effect on the revenue of the central station of maintaining the proper voltage at the lamp. Assume that out of $400,000,000 income to the central stations in the United states, $275,000,000 was the amount paid for lighting. If the voltage drop in each station should be reduced two per cent, the increase in revenue would be four per cent, or $11,000,000. The following Table, No. 2, based on the curve for a 110-volt tungsten-filament lamp as shown in Figure 1, gives the increase in revenue which can be obtained from the circuits by decreasing the drop over all the lines. Assume a connected lamp load of 50 kilowatts operating at an average of six volts under the rated lamp voltage. By decreasing the voltage drop four volts, the increase in revenue to the central station at nine cent energy would be $273.85 per 1,000 hours of operation.

TABLE II. INCREASE IN REVENUE WITH DECREASE IN VOLTAGE DROP.

Kw. Load of Lamps in Service	Gain in Revenue to Central Station per 1,000 Hours by Decreasing Voltage Drop. 2 Volts	4 Volts	6 Volts	8 Volts	10 Volts	12 Volts
50	$ 14.80	$ 30.35	$ 46.65	$ 63.75	$ 81.85	$100.90
100	29.60	60.70	93.30	127.50	163.70	201.80
150	44.40	91.05	139.95	191.25	245.55	302.70
200	59.20	121.40	186.60	255.00	327.40	403.60
250	74.00	151.75	233.25	318.75	409.25	504.50
300	88.80	182.10	279.90	382.50	491.10	605.40
350	103.60	212.45	326.55	446.25	572.95	706.30
400	118.40	242.80	373.20	510.00	654.80	807.20
450	133.20	273.15	419.85	573.75	736.65	908.10
500	148.00	303.50	466.50	637.50	818.50	1009.00

This table has been figured on the basis of one cent per kilowatt. The gain in dollars can be found by multiplying the above figures by any given energy rate.

In Table No. 3, based on the curve for a 110-volt tungsten-filament lamp as shown in Figure 2, is given the per cent increase in candle-power which would result from the decrease in voltage drop. A comparison of Table No. 2 with Table No. 3 will show the increase in service relative to the increase in revenue to the central station.

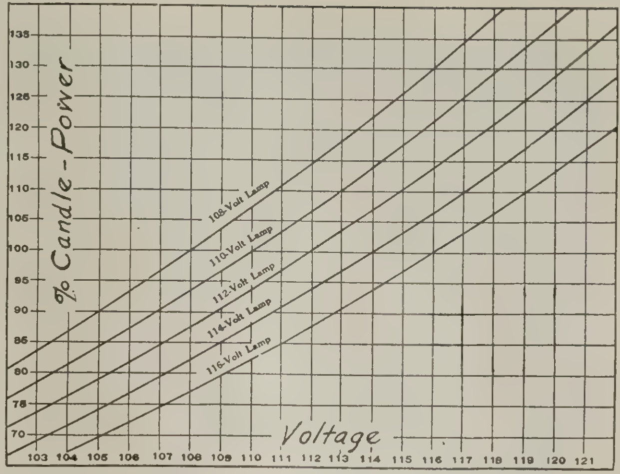


FIG. 2. PER CENT CANDLE-POWER FOR VARIOUS VOLTAGES WITH TUNGSTEN LAMPS.

TABLE NO. III. INCREASE IN CANDLE-POWER FROM DECREASE OF VOLTAGE DROP.

Gain in Per Cent Candle-power to Consumer by Decreasing Voltage Drop.

2 Volts	4 Volts	6 Volts	8 Volts	10 Volts	12 Volts
7.0	14.6	22.9	32.0	41.7	52.6

TRANSLATION OF ENERGY INTO LIGHT.

The relation of operating conditions to the production of light may be stated as the relation between line voltage and lamp voltage. In any electrical supply system the voltage supplied to the customer's premises is bound to vary with the distance of transmission and with the time of day. In making a strictly scientific selection of lamps any particular customer is concerned only with the variations of voltage with time. In selecting a lamp for use on a circuit of fluctuating voltage, various fundamental criteria may be used; that is, the lamp voltage could be selected so that the average of the candle-power values given at all times would be the same as if the lamp were burned continuously at its rated voltage, similarly the wattage consumption or the efficiency might be adjusted for correct average values, or the lamp voltages could be so chosen that the life of the lamp would be the same as when burned continuously at rated voltage. Of the above mentioned factors—candle-power, wattage, efficiency and life—the last will be found to vary more with changes of voltage than any of the others. Hence, if a lamp is so selected that a proper life is obtained, approximately correct values of the candle-power, wattage and efficiency will also be obtained.

It seems to be commonly accepted as a fact, that the average voltage of a circuit during lighting hours is the proper voltage rating for the lamps to be used thereon. Judged from the equivalent life criterion for lamp selection, such is not strictly the case. If a lamp is burned half of the time at a given percentage above this normal value, it will be found that its life is decreased. The magnitude of the decrease will depend upon the difference between the burning voltages and the rated voltage. The reason for this is that in a given period of burning at over-voltage, more of the inherent life of the lamp is consumed than is recovered when burning for an equal length of time at a corresponding amount undervoltage—the net effect being shorter life.

TABLE 4. DATA ON 25-WATT TUNGSTEN LAMP.

% Line Voltage of Lamp Voltage	Initial Candle-power	Initial Watts	C-p-hrs. per 1000 hrs.	Kw-hrs. per 1000 hrs.	Income to Station per Lamp per 1000 hrs.			Renewal Cost per 1000 hrs. List Price	Total Cost to Customer per Lamp per 1000 hrs.			Total Cost to Customer per 1000 c-p-hrs.		
					@ 6 cents	@ 9 cents	@ 12 cents		@ 6 cents	@ 9 cents	@ 12 cents	@ 6 cents	@ 9 cents	@ 12 cents
					Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
96	16.4	23.4	14,310	22 72	136 3	204.4	272.7	28.4	164.7	232.8	301 1	**11.51**	16 26	21.04
97	17.1	23.8	14,860	23.08	138.5	207.7	277.0	32.8	171.3	240.5	309.8	11.52	16.19	20.84
98	17.7	24.2	15,440	23.47	140.9	211.2	281.7	37.8	178.7	249.0	319.5	11.57	16.13	20.69
99	18.4	24.6	16,020	23.86	143 1	214.8	286.2	43.5	186.6	258.3	329.7	11.65	**16.12**	20.58
100	19.1	25.0	16,610	24.24	145.5	218.2	291.0	50.0	195.5	268.2	341.0	11.77	16.14	20.53
101	19.8	25.4	17,240	24.63	147.8	221.7	295.6	57.4	205.2	279.1	353 0	11.90	16.19	**20.48**
102	20.5	25.8	17,860	25.02	150.1	225.2	300.3	65.6	215.7	290.8	365.9	12.07	16.28	20.53
103	21.1	26.2	18,500	25.40	152.5	228.6	305.0	75.2	227.6	303.8	380 2	12.30	16.42	20.56
104	22.0	26.6	19,170	25.78	154.9	232.1	309.7	85.9	240.6	318.0	395.6	12 55	16.59	20.63
105	22.9	27.0	19,870	26.21	157.3	235.9	314.5	98.1	255.4	334.0	412.6	12.85	16.81	20.77
106	23.6	27.4	20,570	26.60	159.6	239.4	319.2	112.1	271.7	351.5	431.3	13.20	17.08	20.97
107	24.5	27.8	21,290	27.00	162.0	244.0	324.0	126.9	288.9	370.9	450.9	13.55	17.41	21.17
108	25.3	28.3	22,030	27.40	164.4	246.6	328.8	144.5	308.9	391.1	473.3	14.02	17.75	21.48

It is evident, therefore, that if during lighting hours the voltage of a circuit fluctuates above and below an average value, the theoretical proper lamp voltage is slightly higher than this average voltage, and the greater the fluctuations, the greater should be the difference between average voltage and lamp voltage.

EXAMPLE OF DETERMINATION OF PROPER LAMP VOLTAGE.

As a general summary of the preceding considerations may be related an investigation made in a city of 130,000 people for the purpose of standardizing the lamp voltage. The business district of this city was supplied with 220-volt, three-wire, direct current and the remainder of the city with 2,300-115-volt alternating current.

At times corresponding to the lighting peak, a large number of voltage readings were taken in the direct current district, particular pains being taken to secure the voltage on both sides of the line at each place tested. These data showed bad conditions of unbalancing—there being in some cases as much as 10 volts difference between the two sides of the line. Since the station was planning to put its direct current circuits underground, it was assumed that in the change the conditions of unbalance would be eliminated. The average voltage of the two sides of the line was therefore recorded for each location tested. After covering the whole direct current district, it was found that the average voltage was 119.5 volts. The voltage was found to vary considerably with distance—from 115 at the outskirts of the district to 125 at points near the plant. Ordinarily under conditions like this, the best recommendation would be to use lamps of different voltages for different parts of the circuit. In view of the fact that when the lines are put underground, they will at the same time be considerably reinforced, it was assumed that the variations of voltage with distance will be materially decreased; and also, since it was very much desired to use the same voltage of lamp throughout the area served, it was recommended that 120-volt lamps should be used universally in the direct current district; 120-volt lamps were recommended, rather than 119-volt, on account of the variations of the voltage, the .5-volt difference between lamp voltage and average line voltage being allowed in conformance with the preceding discussion.

Under the conditions prevailing, the customers near the station would be getting an increased candle-power and a decreased life from their lamps, and the customers at the ends of the lines would be getting a decreased candle-power and an increased life, but the average conditions for the whole district would be as nearly correct as possible.

The voltage conditions on the alternating current system of this station had been greatly improved by the recent installation of automatic induction regulators on each of the ten feeders. These regulators had been carefully placed at the center of load on each feeder and were set to maintain constant voltage at these centers of distribution. Recording voltmeters were placed at these centers and during

TABLE 5. DATA ON 40-WATT TUNGSTEN LAMP.

% Line Voltage of Lamp Voltage	Initial Candle-power	Initial Watts	C-p-hrs. per 1000 hrs.	Kw-hrs. per 1000 hrs.	Income to Station per Lamp per 1000 hrs.			Renewal Cost per 1000 hrs. List Price	Total Cost to Customer per Lamp per 1000 hrs.			Total Cost to Customer per 1000 c-p-hrs.		
					@ 6 cents	@ 9 cents	@ 12 cents		@ 6 cents	@ 9 cents	@ 12 cents	@ 6 cents	@ 9 cents	@ 12 cents
					Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
96	28.0	37.5	24,340	36.72	220.4	330.6	440.8	31.3	251.7	361.9	472.1	10.34	14.86	19.40
97	29.1	38.1	25,290	37.31	223.9	335.8	447.8	36.1	260.0	371.9	483.9	10.28	14.70	19.13
98	30.2	38.7	26,280	37.92	227.5	341.3	455.1	41.6	269.1	382.9	496.7	10.25	14.56	18.90
99	31.3	39.4	27,270	38.57	231.4	347.1	462.8	47.9	279.3	395.0	510.7	**10.24**	14.48	18.71
100	32.5	40.0	28,280	39.19	235.1	352.7	470.3	55.0	290.1	407.7	525.3	10.26	14.41	18.57
101	33.7	40.6	29,330	39.82	238.9	358.4	477.9	63.1	302.0	421.5	541.0	10.29	14.37	18.44
102	34.9	41.3	30,400	40.45	242.2	363.3	484.4	72.2	314.4	435.5	556.6	10.35	**14.33**	18.31
103	36.2	41.9	31,500	41.07	246.4	369.6	492.9	82.7	329.1	452.3	575.6	10.45	14.36	18.27
104	37.5	42.5	32,620	41.70	250.2	375.3	500.4	94.4	344.6	469.7	594.8	10.56	14.40	18.24
105	38.9	43.2	33,830	42.38	254.2	381.4	508.5	107.8	362.0	489.2	616.3	10.70	14.46	**18.22**
106	40.2	43.9	35,000	43.00	258.0	387.0	516.0	123.3	381.3	510.3	639.3	10.89	14.58	18.25
107	41.6	44.5	36,240	43.65	261.9	393.9	523.8	139.6	401.5	533.5	663.4	11.08	14.72	18.30
108	43.1	45.2	37,500	44.30	265.8	398.7	531.7	159.0	424.8	557.7	690.7	11.33	14.87	18.42

TABLE 6. DATA ON 60-WATT TUNGSTEN LAMP.

% Line Voltage of Lamp Voltage	Initial Candle-power	Initial Watts	C-p-hrs. per 1000 hrs.	Kw-hrs. per 1000 hrs.	Income to Station per Lamp per 1000 hrs.			Renewal Cost per 1000 hrs. List Price	Total Cost to Customer per Lamp per 1000 hrs.			Total Cost to Customer per 1000 c-p-hrs.		
					@ 6 cents	@ 9 cents	@ 12 cents		@ 6 cents	@ 9 cents	@ 12 cents	@ 6 cents	@ 9 cents	@ 12 cents
					Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
96	43.7	56.2	38,060	55.10	313.7	470.6	627.4	42.7	356.4	513.3	670.1	9.37	13.48	17.61
97	45.4	57.1	39,520	55.96	318.8	478.2	637.6	49.2	368.0	527.4	686.8	9.32	13.34	17.38
98	47.2	58.1	41,060	56.93	324.1	486.2	648.2	56.7	380.8	542.9	704.9	9.28	13.22	17.17
99	49.0	59.0	42,600	57.86	329.3	494.0	658.7	65.2	394.5	559.2	723.9	**9.26**	13.13	16.99
100	50.8	60.0	44,180	58.80	334.8	502.2	669.6	75.0	409.8	577.2	744.6	9.28	13.06	16.85
101	52.7	61.0	45,830	59.74	340.3	510.4	680.6	86.0	426.3	596.4	766.6	9.30	13.02	16.73
102	54.6	61.9	47,500	60.68	345.7	518.5	691.4	98.6	444.3	617.1	790.0	9.35	**12.98**	16.63
103	56.6	62.9	49,230	61.60	351.0	526.5	702.0	112.7	463.7	639.2	814.7	9.42	**12.98**	16.55
104	58.6	63.9	51,000	62.56	356.4	534.6	712.8	128.9	485.3	663.5	841.7	9.52	13.01	16.51
105	60.6	64.9	52,800	63.54	361.8	542.7	723.6	147.0	508.8	689.7	870.6	9.63	13.06	**16.49**
106	62.9	65.8	54,700	64.53	367.3	551.0	734.7	168.1	535.4	719.1	902.8	9.79	13.14	16.50
107	65.1	66.8	56,630	65.51	372.9	559.4	745.8	190.4	563.3	749.8	936.2	9.94	13.24	16.53
108	67.4	67.8	58,600	66.48	378.4	567.6	756.8	216.7	595.1	784.3	973.5	10.15	13.38	16.60

the lighting hours a number of voltage readings were secured at the extreme ends of the lines supplied from each center. Comparison of these readings with the indications of the recording voltmeters gave data as to the maximum drop from center of distribution to the extreme load. Consideration will show that the average of the voltage drops from a center of distribution to all of the individual loads will be more than half of the drop from the center of distribution to the farthest load. A theoretical calculation showed that the former will, in most cases, be approximately 70 per cent of the latter. Taking 70 per cent of the average maximum drop on each feeder, and adding this to the desired lamp voltage, the voltage is obtained for which the feeder regulator should be set.

The voltage readings and determinations of line drop were all made during the time of heavy lighting, that is, between 5 and 10 p. m. Of course, some lamps are in use after this period, and the voltage is liable to be higher than during the early part of the evening, but the number of lamps which are in use after 10 p. m. will be so small compared to the number in use during the early evening that the voltage conditions prevailing after 10 p. m. can be well neglected in making any general selection of lamps.

REVENUE AND SERVICE.

Tables 4, 5, 6 and 7 show what economic results will be obtained by burning some of the common types of lamps at various voltages. These tables show, for energy rates of 6, 9 and 12 cents per kw-hr., the increase of income to the station for various percentages of normal lamp voltage ranging from 96 per cent to 108 per cent. The total cost (energy cost plus lamp cost) to the customer is also shown together with the cost per unit of light (1,000 cp-hrs.). The bold face figures in the unit cost colmns indicate the percentage of normal voltage at which the customer will secure light for the minimum total expenditure per unit. An inspection of these columns will show that there is a considerable range of operation both above and below the point of maximum economy over which the unit cost of light changes by an almost negligible amount. Take for example the 40-watt tungsten-filament lamp operating on six-cent energy. The table shows that if the lamp is burned at one per cent undervoltage, the maximum economy will result, the cost per 1,000 cp-hrs. in this case being 10.24 cents. It will be noticed that over a range of three per cent in voltage on both sides of this point, the unit cost to the cutsomer increases by only 1 per cent. Corresponding to operation at three per cent below the point of maximum economy, the revenue to the station is $2.204 at the point of maximum economy it is $2.314, and at three per cent above it it $2.422, or the relative percentages are 95.2 per cent, 100 per cent and 104.5 per cent.

Suppose that a central station were so operating that, due to line drop or other voltage losses, the lamps were operating at three per cent below the point of maximum

TABLE 7. DATA ON 60-WATT METALLIZED CARBON LAMP.

% Line Voltage of Lamp Voltage	Initial Candle-power	Initial Watts	C-p-hrs. per 1000 hrs.	Kw-hrs. per 1000 hrs.	Income to Station per Lamp per 1000 hrs.			Renewal Cost per 1000 hrs. List Price	Net Income to Station per Lamp per 1000 hrs.			Total Cost to Customer per Lamp per 1000 hrs.			Total Cost to Customer per 1000 c-p-hrs.		
					@ 6 cents	@ 9 cents	@ 12 cents		@ 6 cents	@ 9 cents	@ 12 cents	@ 6 cents	@ 9 cents	@ 12 cents	@ 6 cents	@ 9 cents	@ 12 cents
					Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
96	19.7	55.8	16,350	53.51	321.1	481.6	642.1	13.9	307.2	467.7	628.2	335.0	495.5	656.0	20.48	30.30	40.12
97	20.7	56.8	17,200	54.55	327.3	490.9	654.6	16.7	310.6	474.2	637.9	344.0	507.6	671.3	20.00	29.52	39.03
98	21.8	57.9	18,060	55.53	333.2	499.7	666.3	20.0	313.2	479.7	646.3	353.2	519.7	683.6	19.56	28.77	37.86
99	22.9	58.9	18,970	56.56	339.4	509.1	678.8	23.9	315.5	485.2	654.9	363.3	533.0	702.7	19.15	28.10	37.03
100	24.0	60.0	19,920	57.60	345.6	518.4	691.2	28.6	317.0	489.8	662.6	374.2	547.0	719.8	18.79	27.46	36.14
101	25.2	61.1	20,900	58.64	351.8	527.7	703.6	34.1	**317.7**	493.6	669.5	385.9	561.8	737.7	18.46	26.87	35.28
102	26.4	62.2	21,910	59.67	358.0	537.1	716.1	40.5	317.5	496.6	675.5	398.5	577.6	756.6	18.20	26.37	34.54
103	27.7	63.3	22,980	60.71	364.3	546.4	728.5	48.1	316.2	498.3	680.4	412.4	594.5	776.6	17.95	25.88	33.80
104	29.0	64.4	24,080	61.81	370.8	556.3	741.7	57.0	313.8	**499.3**	684.7	427.8	613.3	798.7	17.76	25.47	33.16
105	30.4	65.5	25,220	62.84	377.0	565.6	754.1	67.4	309.4	498.2	686.7	444.4	633.0	822.5	17.63	25.12	32.62
106	31.8	66.6	26,420	63.94	383.6	575.4	767.3	79.7	303.9	495.7	**687.6**	463.3	655.1	847.0	**17.54**	24.80	32.07
107	33.3	67.7	27,610	65.03	390.2	585.3	780.4	94.0	296.2	491.3	686.4	484.2	679.3	874.4	**17.54**	24.60	31.68
108	34.8	68.8	28,880	66.13	396.8	595.2	793.5	110.9	285.9	484.3	682.6	507.7	706.1	904.4	17.62	24.52	31.40

economy. By eliminating a portion of the voltage losses or by arbitrarily raising the station voltage three per cent in order to counterbalance these losses, the central station could increase its revenue five per cent, furnish 12 per cent more light, and improve the economy of light production by one per cent. By eliminating still more of the losses and thus supplying six per cent more than the original voltage, the revenue could be increased 10 per cent. At the same time, the customer would secure 24 per cent more light at no greater cost per unit.

Nothing has yet been said about lamp renewals, since in nearly all cases tungsten-filament lamps are not given as free renewals. Even with metallized-carbon-filament lamps the large majority of central stations do not follow a free renewal policy.

Viewed only from the standpoint of income to the central station, there is no limit to the increase of voltage which will prove profitable, provided the customer supplies his own lamps. From the standpoint of the customer, however, the increase in renewal expense makes it inadvisable for the central station to increase its voltage beyond the point at which the lamps will still give a satisfactory life.

The question as to what lamp life will prove satisfactory depends largely upon the customer. In most cases he is willing to purchase one tungsten-filament lamp every six to nine months for each of the sockets equipped therewith, but a shorter life than this would possibly result in complaints. When it is considered that in 1,000 hours operation a 60-watt, tungsten-filament lamp will consume ten times its list price cost in energy (assuming nine cents per kilowatt hour) and in the same period a 60-watt, metallized-filament lamp will consume 27 times its list price cost in energy, it will be seen that the question of the cost of energy for the light delivered is of relatively far greater importance than that of lamp renewal cost. Under a free renewal policy, the voltage increase which would prove profitable to the central station is limited, due to the fact that beyond a certain point the renewal expense increases faster than the total income.

As regards the relation between the rated voltage of lamps and the voltage at which it is economical and profitable to burn them, a consideration of the tables will show that in general the latter is higher. In a great many cases it is true that it is more profitable to the central station and gives the customer more for his money to burn the lamps over the rated lamp voltage rather than under the rated lamp voltage.

Some Facts and Figures on Installing Ornamental Street Lighting Systems.

(*Contributed Exclusively to* Southern Electrician)

ALAN BRIGHT, ILLUMINATING ENGINEER, MACBETH-EVANS GLASS COMPANY.

A GREAT deal has been said concerning the merits and demerits of the ornamental or decorative system of street lighting. We have witnessed with interest the remarkable progress this system of lighting has made. Three years ago ornamental lighting was looked upon as an expensive luxury that would probably be used only for small installations put in privately by individuals or for the exterior lighting of public buildings. The idea that this form of lghting would be adopted generally to light entire business sections of large cities was not appreciated at that time. The use of rolled metal and concrete standards mounted with tungsten lamps enclosed in diffusing ball globes has however advanced until at the present time from two hundred and fifty to five hundred cities in this country and Canada have adopted this form of street illumination to light their main thoroughfares. Articles describing typical installations in various localities have appeared from time to time, giving details of construction, new methods of control, etc., yet very lttle data that relates to the actual cost of installing and maintaining such a system is available. This is probably due to the fact that cost data of value on this subject is difficult to secure for costs vary through wide limits in different cities. Civic conditions and personal opinions all govern these street lighting matters with varying results. The large cities seem to be more conservative and are not prone to changes that mean the replacing of costly systems already in use with something else that involves large capital. More of the smaller cities however have adopted the ornamental lighting throughout for the reason that they are simply putting in a new system without replacing an old one.

It is impossible to prepare a set of figures giving the probable cost per post or cost per foot of street that will apply in all places, for transportation costs and elaborateness of design influence the cost of posts, and labor charges, local conditions, etc., influence the cost of installing.

THE DIVISION OF COSTS.

A question over which there has been a great deal of disputation and to little avail, is just what portion of the total expense of an improved street lighting system should be borne by the property owners and what portion should be taken care of by the city. Quite often the local central station also bears its share. Improved street lighting in a business district is a commodity enjoyed by the merchants or tenants who benefit financially from it and should therefore be paid for by them. Ornamental posts in front of a store convince people that the owner of the store is progressive and up to date and realizing this, most merchants are willing to bear their share of the expense willingly.

It is seemingly impossible to determine just what part of the expense of putting in a lighting system should be borne by the city. In outlying districts as along boulevards and through parks, there is no question but that the city should bear the whole expense. The public enjoys it and the people owning property facing on such thoroughfares benefit only insofar as the improved general appearance tends to increase property values.

Quite often there seems to be little assistance on the

part of the central station in starting movements for better street lighting. There is a reason for this, however, for when electric light companies suggest changes or go on record as favoring some new thing, the consumers of electric power immediately become suspicious, their imaginations seeming to tell them that all such movements are schemes on the part of the electric light companies to increase their revenue. As central stations do not care to be regarded in this light they would much prefer that others would take the initiative and introduce these new ideas.

COSTS IN SPECIFIED CASES.

The cost of a single standard, not including the power station equipment, interest charges, supervision etc., is given in the following table:

For one 5-light ornamental iron standard:

First cost post	$ 35.00
Lamps and sockets	5.60
Glass Globes	4.00
Erecting wiring (post) and concrete base	8.00
Supply cable (65-ft lead, jute and steel at 25c)	16.25
Laying cable at 60c per foot	39.00
Total cost per post	$107.85

In making use of this table, due modifications should be made for specific cases. Transportation costs and elaborateness of design will influence the costs of the posts. Labor charges control to some extent the fourth and sixth items. The above estimate has however been made up with the understanding that the work necessitates the chipping of a trench in the cement walk. If this is not required, the cost of the work should be considerably less.

The mention of actual costs in a few typical installations may not only be of interest but may be of some assistance to those who are planning new installations. A worthy installation that has attracted a great deal of attention since it was put in, is that installed on the Lake Shore Drive in Chicago. Here 150 single light reinforced concrete standards of artistic design are used. Each post is mounted with a 7½ ampere series Jandus arc lamp enclosed in a 20 inch Alba diffusing ball globe. Each one consumes 490 watts and has a horizontal candle-power of 1000. The installation is divided into two circuits on each side of the street. All lamps burn until midnight, when those on one side of the street are put out and the others are left burning until dawn.

The approximate cost of the installation is $232.00 per post. This cost consists of the following items: Power station equipment; lamp posts, lamps, globes and ornamental bronze trimmings; underground construction and cable; construction labor; supervision and tools. This cost as stated above may seem to be somewhat high, probably due to the fact that arc lamps are used on each standard and that the costs of power station equipment, supervision, etc., which are not ordinarily referred to in the cost per standard, are included. Besides the Lake Shore Drive installation, several other boulevards in this part of Chicago are lighted in a similar way. In this city 591 such standards are in use.

Another similar installation is that on the campus of the University of Washington in Seattle, Wash. About 78 single light posts are distributed over the campus. Each post is equipped with a single tungsten lamp. The cost of this pole is as follows:

Bare pole (gravel $2.80 per yard, cement $2.65 per barrel)	$14.50
Average cost of erection	.80
Pole foundation and anchors	6.00
Pole trimmings, lamp, globe, transformers, etc.	16.20
Labor, wiring pole, placing lamp, leveling, etc.	1.00
Total	$38.50

This cost is unusually low, due to the fact that the labor was entirely furnished by student engineers, and all castings were made at the University foundry.

The new lighting system on Nicollet avenue, Minneapolis, Minn., has eight five-light standards per block. The posts are spaced 100 feet apart and support five 100-watt tungsten lamps. The cost of installing and maintenance for one year, including the electric current, was $2.50 per running foot, which sum was subscribed in some cases by property owners, in others by tenants, and in still others by property owners and tenants jointly. It costs practically $60.00 per

Fig. 1. Day View of Ornamental System at Hamilton, Ohio.

FIG. 2. NIGHT VIEW OF BOARD WALK, ATLANTIC CITY, N. J.

year for maintaining each standard. This includes cost of current, keeping standards painted and turning lights on and off.

In Cedar Rapids, Iowa, the property owners paid $100 per post, the tenants pay $70 per post per year or 10 cents per front foot to cover expenses of operating, painting, lamp and globe renewals, inspection and control.

The ornamental system in Pasco, Wash., was installed complete with lamps, globes, controlling switches, etc., at a cost of $100.00 per post, which was borne by the city. The installation cost was handled by the creation of a special improvement district and the cost of installing was assessed against the property directly benefiting.

In Hamilton, Ohio, (for the system shown in Fig. 1) the tenants pay $12.00 per front foot per year. The property owners through the wide awake "commercial club" have paid $80.00 per post for the complete installation.

In a few cities as in Racine, Wis., the total cost becomes a tax against the property as a permanent improvement and is put on the tax books and collected from the tenant by the owner.

The Pine Bluff, Ark., installation is an excellent example of what a city of 2,500 population can do in the way of improving its lighting system without overburdening the property owners. In this city 150 posts of simple design have been erected. Four 16-inch globes are mounted on iron pipe brackets supported by iron pipe posts. They are set firmly in concrete and cost complete $24.00 each. The plan of operating the white way consists of a scheme whereby the merchant pays $5.00 per month for one year, at the end of which time the post becomes the property of the merchant. After the first year he pays the light company $3.00 per month per pole for lighting and up-keep.

In Peoria, Ill., the lighting system was installed at the expense of the benefiting property owners and ground floor tenants at the rate of $2.20 per property front foot, the proportion of this cost that the property owner and his tenant should pay for the frontage involved being left to them to decide and in some few cases the tenant paid the full amount.

One of the most prominent of the recent installations is the new system of lighting the famous boardwalk in Atlantic City, N. J., shown in Fig. 2. This well known promenade was formerly lighted with arc lamps and festoons of incandescent lamps. These have been taken away and replaced by ornamental iron standards of rather unique design. Each standard supports four 60-watt lamps and one 100-watt lamp enclosed in Alba globes. The top globe

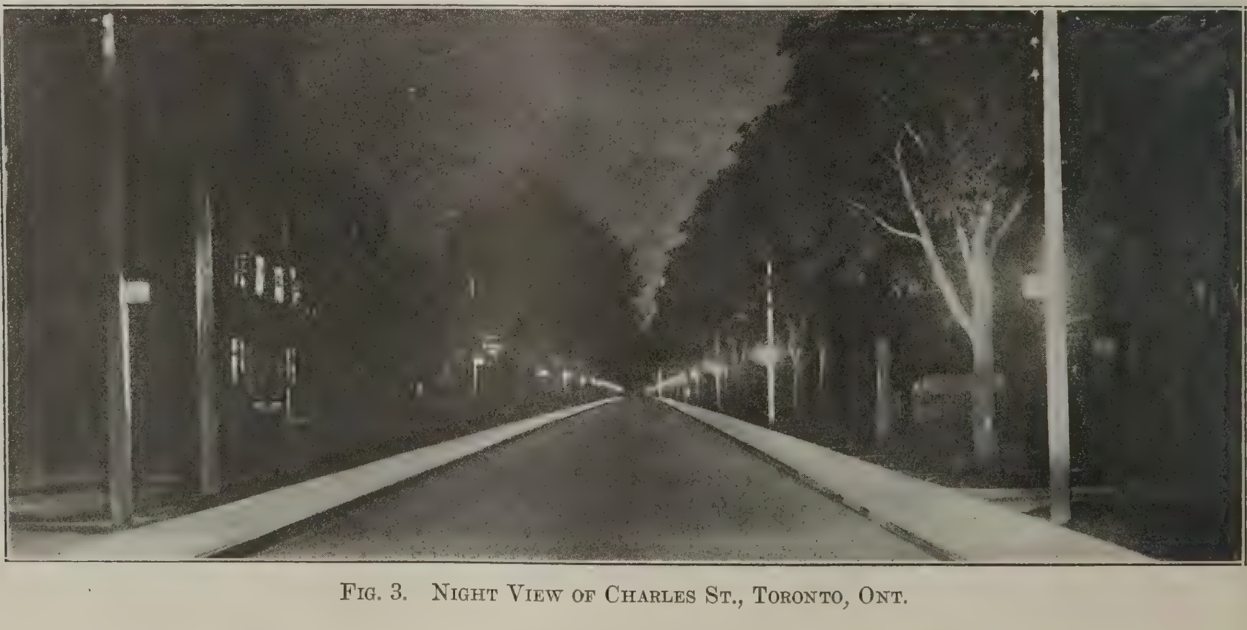


FIG. 3. NIGHT VIEW OF CHARLES ST., TORONTO, ONT.

is raised some distance above the four pendant globes, an arrangement unlike that in any other city. There are 302 standards spaced at 65 feet apart extended over a distance of three and a half miles. Three-wire 110-220-volt alternating current is used. Switch control boxes for the incandescent lamps are located at alternate street intersections so that each switch turns on and off two blocks of standards, one in either direction. The standards cost approximately $90.00 each. The "under the boardwalk" distribution system cost approximately $50.00 per standard. This cost is considerably higher than would be expected as one would suppose a system where no underground construction is necessary, to cost appreciably less than one where the distributing wires are placed beneath expensive pavements in steel protected insulated cable costing 25 cents a foot or more. However, the extreme atmospheric conditions at Atlantic City has caused the distribution system to compare in cost very closely to that of underground systems in other cities.

RESIDENTIAL ORNAMENTAL LIGHTING.

Ornamental street lighting is generally confined to business streets or to boulevards and parks where plenty of traffic warrants the installation of elaborate concrete or metal standards and expensive underground construction. In residence districts where streets are comparatively little used, old types of arc, incandescent and oil lamps are frequently seen. Quite often attempts have been made to devise some sort of ornamental unit for use in rural districts, but in most cases the excessive cost will not warrant an installation. However, in Toronto, Ontario, as shown in Fig. 3, the residents of Charles street have adopted a system of lighting that is not only attractive and efficient, but very inexpensive. On light wooden poles set inside the sidewalks are mounted cast iron lantern-like brackets holding an 8x8 inch Alba cylinder that encloses a 150-watt tungsten lamp. The system produces an illumination quite ample for residential streets with all the novel and decorative effects of an ornamental system. Some of the Pacific coast cities have adopted this system for lighting streets in rural districts.

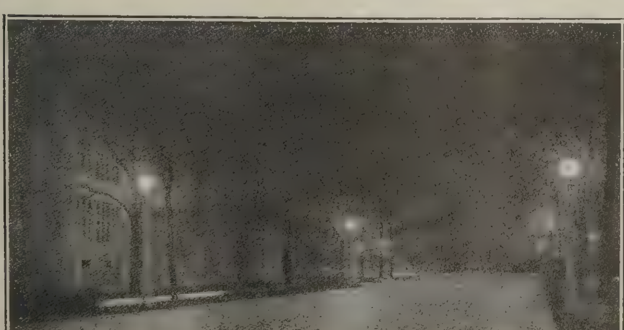
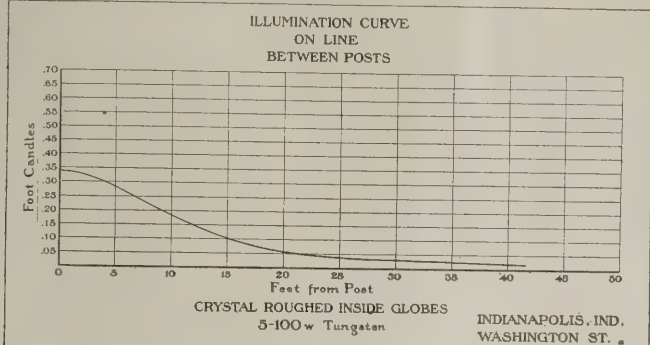
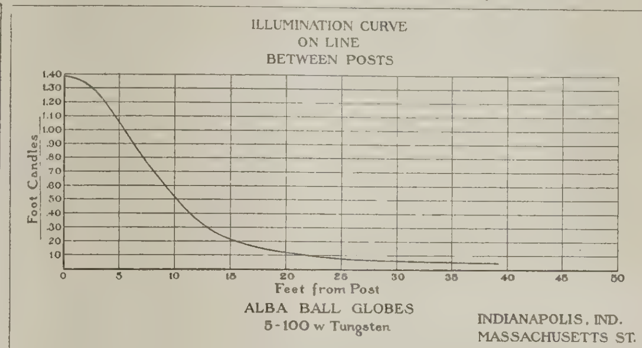


FIG. 4. ENTRANCE TO LINCOLN PARK, CHICAGO.

ILLUMINATION CURVES.

The illumination curves in Fig. 5 and Fig. 6 show the actual values of illumination secured about an ornamental standard in actual service. The readings were taken with a portable photometer on Washington street and on Massachusetts avenue in Indianapolis, Ind. The measurements were made on a 36-inch plane on a line extending between two adjacent posts at points a few feet apart. The curves are plotted to vertical scale of foot candles and a horizontal scale of distance in feet from the foot of the post. Fig. 5 shows the illumination resulting from a five-light standard equipped with five 100-watt tungsten lamps enclosed in crystal roughed inside ball globes. Fig. 6 shows that resulting from a five-light post supporting five 100-watt tungsten lamps in Alba ball globes.





FIGS. 5 AND 6. ILLUMINATION CURVES.

The following table gives some details of typical installations in four prominent cities:

	Dayton, Ohio	Indianapolis, Ind.	Toronto, Ont.	Buffalo, N. Y.
Watts per lineal foot	8.71	12.8	9.85	5.68
Watts per square foot	0.173	0.211	0.235	0.095
Average horizontal foot candles	0.092	0.179	0.175	0.093

The information set forth is of a very general nature. The article does not pretend to cover the subject, but to simply call attention to a few points that may be of interest to those contemplating new installations.

In addition to losses in the mining and concentration of zinc ores, there are incalculable losses, which without question run into many millions of dollars and undoubtedly exceed the total value of the zinc mined, in slags and waste products from other sources.

Our wastes of nitrogen are almost inconceivable and no calculation can give an idea what these losses mean.

The total amount of sulphur discharged in the air from smelters would make more than 9,000,000 tons of sulphuric acid. CHARLES L. PARSONS, of the Bureau of Mines.

The Commercial and Engineering Features of Industrial Lighting Systems.

(*Contributed Exclusively to* Southern Electrician)

BY H. A. REID, INDUSTRIAL LIGHTING ENGINEER
NATIONAL ELECTRIC LAMP ASSOCIATION.

The Economy of Good Lighting in Industrial Plants and the Proper Equipment and Layout for Textile Mills.

IN the development of scientific principles in cotton mills and industrial plants of all kinds, the use of high efficiency lamps and scientifically designed systems of illumination play a very important part. The effect of good illumination upon the output and general conditions of a plant has, during the last few years, become very well appreciated by managers and engineers. Any improvement or invention which will increase or improve the output, decrease the cost of production, or eliminate waste, is gladly received and adopted by the more progressive plants and factories. And further, any slight improvement in the amount or quality of the output will justify a comparatively large expenditure in the methods of securing it. Managers of progressive industrial plants have repeatedly proved that the installation of a scientifically designed system of illumination exerts an influence upon the output which far more than balances the cost of this improved illumination. Compared to the cost of labor and other costs of production, the expense of an adequate system of lighting with Mazda lamps is insignificant.

While it is rather difficult to show the exact effect of the illumination upon the output, numerous plants report that since installing an adequate lighting system, their output has either been increased or its quality has been markedly improved. One Pittsburg plant ascertained from a study of the hourly output, that the production dropped 30 per cent on dark days. How much more important then, is good illumination during the morning and afternoon hours and during the night for those plants which have a night shift? Calculations show that in most industrial plants, if each man can save 2½ to 3 minutes per day, that saving will pay for an excellent system of illumination with high-efficiency lamps.

The labor problem is one of the most serious with which managers of industrial plants are confronted. Good illumination, by increasing the cheerfulness of the surroundings, exerts a powerful influence upon the attitude of the employee toward the firm by whom he is employed. If a man's loyalty can be assured, the firm will profit not only because of the additional work which he will do but because it will be possible to build up an organization of good, reliable, efficient employees who can be counted on to remain with the firm and thus eliminate the necessity of continually breaking in new operators.

Not only is a man's term of service to one employer increased but his period of service as a workman is lengthened by the reduction of eye strain, which is a very frequent cause for the shortening of a man's time of service as a first-class workman. Eye strain may be caused by attempting to do fine work under too low an intensity of light or by the glare due to the use of unprotected illuminants in the ordinary range of vision. This applies equally to the use of unprotected local units hung low over a machine in front of the operative and to the use of high candle-power, glaring lamps for general illumination.

Non-uniform illumination throughout a room also has a harmful effect upon the eyes of the workman. When the eye becomes adjusted to seeing under a certain intensity of illumination, it has to readjust and refocus itself before anything can be seen under an intensity which differs greatly from the first. Everyone has experienced the temporary blindness caused by passing from a brightly lighted room to one dimly lighted or vice versa.

The use of flickering light sources is another cause of eye strain and eye fatigue. The effect is even more harmful than non-uniformity, as it is impossible to obtain constant illumination even on a comparatively small working surface. With a non-flickering source of light, even if the system is not designed to give uniform illumination throughout the room, the intensity at any one point will always remain constant.

In considering the effect of lighting upon the operatives, the importance of good lighting as a means of prevention of accidents must not be neglected. Of about one-half million avoidable accidents in the United States in one year, it has been estimated by authorities on the subject of accident prevention that 25 per cent were due to improper or insufficient illumination. If the cost of these accidents to the company were added to the cost of light, as they properly should be, the maintenance of the inadequate

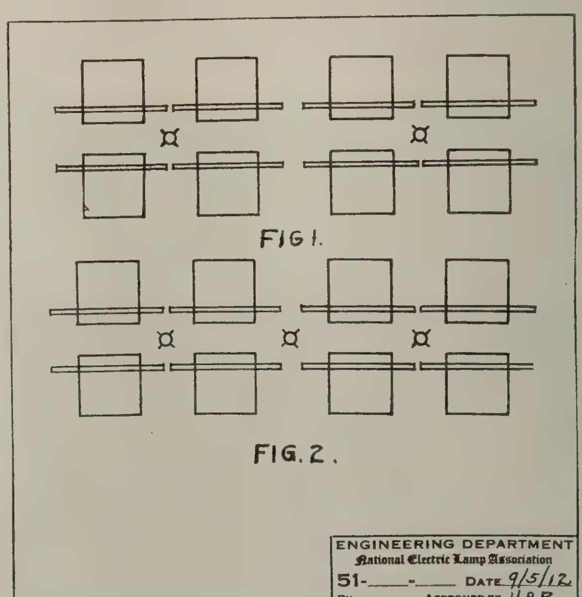


Fig. 1. Lighting Layout for Looms on Light Colored Goods. Fig. 2. Lighting Layout for Looms on Dark Goods.

system would rise out of all proportions to the other costs of production. In a majority of cases, it will be found that the cost of a good system of illumination which will afford ample protection for the workmen, will cost no more or perhaps even less than the inadequate obsolete system under which the majority of men have been accustomed to work.

The foregoing paragraphs while quite general in their nature apply with even more than usual force to the conditions which exist in the mills of the South. Here a 16-candle-power-carbon lamp, often bare, over each loom has long been the standard method of illumination. Conditions are rapidly changing, however, and the rugged, high-efficiency, drawn-wire tungsten-filment lamps are succeeding the obsolete units now in use.

It is not the intention in this article to attempt to provide complete specifications for lighting a texile mill, as recommendations must be governed by local conditions, such as location of machinery and shafting, height of ceiling, color of goods, cost of power, etc. A few general points, however, will be taken up. The most satisfactory system for most departments is what is technically known as localized general illumination, i. e., good general lighting by means of overhead units spaced with particular reference to the machines which they are expected to light.

Consider for example the lighting of the looms. For light colored goods, the looms can be properly lighted by 1 60-watt Mazda lamp, fitted with a suitable glass or steel reflector for every four looms, as shown in Fig. 1. For dark goods, 1 60-watt lamp should be provided for every two looms as shown in Fig. 2. They should be located in the weaver's alley, between machines so that the light coming from both sides minimizes the shadow of the operator's body upon the important parts of the work.

The question of the proper reflector is by no means an unimportant one. The reflector should be deep enough to protect the eyes of the workmen from the bare lamp filament and at the same time should be so designed that an efficient and satisfactory distribution of light is provided. Lines of both steel and glass reflectors which fulfill these requirements are available. The choice between the two systems depends upon considerations of a practical nature.

While the steel reflectors give more directly reflected light upon the working plane, the direct light from the glass reflectors is reinforced by light from the walls and ceilings. This light which passes through the glass reflectors gives a more cheerful and pleasing appearance to the mill, but even with the steel units sufficient light is reflected from the brightly lighted goods to furnish well diffused illumination in the upper part of the room for making repairs on shafting, etc.

From the standpoint of broken reflectors, damage caused by falling glass and depreciation due to dust and dirt, the enamelled steel reflectors are superior. They can very easily be cleaned in place with a damp cloth. In view of these considerations, steel reflectors are now being installed in a majority of new installations. With the complete line of lamps and reflectors now on the market, it is possible to secure illumination for all parts of a textile mill which is not only theoretically correct but economical and practical as well.

Recent Lighting in England.

(*Contributed Exclusively to* Southern Electrician)

BY R. E. NEALE, A. C. G. I., B. SC.

TE salient feature in the lighting field during the past year is the enormous increase in the popularity and utilization of the metal filament lamp. The reduced price and improved construction of the tungsten lamp have led to so wide a use of the latter that the recovery of a number of small central stations from the metal filament "crisis" has been postponed for a further year or two. In the majority of undertakings, however, the great increase in the industrial load and in the total number of lamps connected during 1907-09 has fully compensated the reduction in the energy sales per 1,000 candle-power hours. Had the metallic filament been originally introduced in its present form, the effect on central stations would have been appalling.

Though home manufacturers have made great advances in the quantity of their output, while the quality is of the best, German makers lead on a quantity basis with the enormous annual output of about 30-40 millions each of carbon and metal incandescent lamps in addition to vast numbers of mercury and other arc lamps.

There has been considerable discussion recently as to the relative strength of drawn and compressed tungsten lamps. The drawn filament is certainly far the stronger before it has been incandesced for any considerable period. This fact enables very economical manufacture and the use of single-piece filaments wound on flexible supports, while the breakage of new lamp filaments in transit is reduced to a negligible percentage. The advocates of the drawn filament lamp state that the wire filament retains its advantage as compared with squirted filaments throughout its life and apparently incontrovertible data are advanced in support of this claim. On the other hand, the devotees of the squirted filaments while admitting the cost and risk variation in the manufacture of this type, claim that the mechanical strength of the squirted thread increases by a sintering and welding action during service, whereas that of a wire filament rapidly decreases by the assumption of a brittle crystalline state (in contrast to the extreme malleability and ductibility induced in the metal by hammering and rolling before drawing).

These limitations of the drawn filaments are not admitted by the manufacturers and it is beyond the power of any persons outside lamp factories or large lamp using concerns to collect any reliable data bearing on the question, hence it is best to state the chief arguments for and against the two types of filaments and to leave the conclusion to personal experience. Several large purchasers have informed

the writer that they have found the best drawn filaments no better, in service, than the best squirted filaments. Even if this be so, the greater strength of the new wire lamps is an important practical advantage sufficient to turn the scale i ntheir favor so long as their service performance is not materially inferior to that of squirted filaments—which certainly does not appear to be the case.

The "intensive" Osram lamp built to provide from 200 to 1,000 hefners per lamp for 1,000 to 1,500 hours minimum life at an efficiency of 0.8 to 0.9 watts per hefner, is steadily gaining favor as a lighting unit for yards, stations, works, etc., and there seems no doubt that metal filament lamps will replace comparatively modern arcs in many services and will, in many more cases, be substituted for older arcs and gas lanterns as these become defective. At Dover the old Brush arc lamps (1895) were converted to flame carbons a few years ago and last year metallic filament clusters of four 100 cp units were placed in lanterns and connected through 50/100 volt autotransformers to the original 750 watts; 2000/50 volt transformers in the standard base. The use of autotransformers in house lighting metallic filament installations is on the wane. With the improved construction and reduced cost of medium candle-power, high voltage metal lamps there is no longer sufficient advantage, in the use of autotransformers, to justify the cost of their installation, their light losses and their unfavorable effect on the supply power factor.

Considerable attention has lately been devoted to the use of condensers in conjunction with low voltage metal lamps on high voltage supply, and there is no doubt that the condensers now marketed for the purpose compare very favoraby with autotransformers. They take a leading instead of lagging current and have 98 to 99 per cent efficiency on full load and have no light load losses. The cost of their installation is very moderate, but their chief field of application has vanished with the improvement of the metallic filament lamp. It has been suggested that the series system of supplying blocks of flats or tenement dwellings using low voltage lamps and condensers makes central station supply possible in a field hitherto economically beyond the pale. There is no reason why this should not be so in certain town areas.

An increasing amount of attention is being paid to the use of efficient globes and reflectors in conjunction with metallic lamps. On the continent various special filament arrangements (conical and so forth) have been tried with the same end in view, viz., improved distribution of light. Purely indirect lighting is fortunately going out of favor for domestic interiors, audience halls and so on. Though excellent for drawing offices and other special cases where a shadowless illumination is desired, purely indirect lighting gives unnatural, flat and depressing effects in ordinary interiors and semi-indirect fittings are, very properly, coming into great favor. Extreme uniformity of illumination is not wanted in halls, meeting rooms and the like. A far more pleasing result is obtained by plenty of variation in illumination, the foot-candles at each spot being suited to the needs of the surrounding area and sharp contrasts being rigidly avoided.

No important new type of lamp has been introduced during the past year. The Neon lamp has been favorably reported upon by various persons who have given it a trial, and it offers a number of advantages as compared with the Moore lamp to which it is outwardly very similar. The manufacturing difficulties are considerable but appear quite surmountable and the rarity of the gas is a minor objection since 3.5 cubic feet per diem are obtained as a by-product in an oxygen separating plant yields 1,750 cubic feet of oxygen per hour. This quantity of Neon suffices to fill 800-1,000 six-metre tubes yielding about 200 cp per yard. The present types of Neon lamps require 800-1,000 volts per yard plus 150 volts at each electrode and a length of at least 20 feet (requiring about 1,200 volts), is desirable for efficiency. At present alternating current supply is imperative, but it is hoped to evolve direct current lamps shortly. The light emitted is reddish with an entire absence of blue rays; long tubes with large electrodes have a burning life exceeding 1,000 hours, and the efficiency of 0.9 to 0.45 watts per mean Spher. cp (better value being reached in very long tubes) is a practical efficiency actually obtained throughout the life of a lamp.

The magnetic arc lamp is not used to any appreciable extent in this country, a fact which is only partly accounted for by the difference in the conditions to be met.

No noticeable advance has been made in street lighting practice, if we except the increasing application of metallic lamps and high efficiency reflector fittings and lanterns. The "white ways" which form so striking a feature of progressive American cities are unknown on this side, and the idea is generally deprecated as hopelessly extravagant. There is no doubt that the expenditure is fully justified in the circumstances in which "white ways" have been installed, but a recent contributor to the London Electrical Review, who tried to explain this point and to arouse general interest in the matter seems to have been misunderstood.

In the house supply field one of the most important developments has been the introduction of improved automatic petrol-electric sets working in conjunction with an accumulator battery of size varying with the system employed. Those systems employing a large battery are handicapped by the capital outlay, space and attendance required. One of the best equipments the writer has met with personally is the Bruston-Lister set. The battery employed is of ignition type and capacity. The petrol electric set is started automatically, directly more than, say, four lamps are switched in or after a fewer number of lamps have been supplied from the cells for sufficient time to reduce their voltage to the critical value for which the relay is set. The chief difficulty experienced has been to maintain the cells in a state of proper charge when supplying small loads for long periods. It will be clear, on consideration, that the battery tends to hover near the critical relay voltage. An improved relay design has now overcome the difficulty.

Low voltage metal lamps supplied from accumulators recharged at the nearest central station offer a cheaper means of lighting houses within reasonable distance of public areas. In the days of the carbon lamp and heavy load accumulators, the proposition was impracticable, but with "one watt" metal lamps and durable batteries offering at least 12 watt hours capacity per pound weight, the scheme is quite feasible, and its advantages will increase with every improvement in lamp and accumulator manufacture. Assuming a 500-watt 25-volt installation and a maximum winter evening consumption of 800 watt hours, a suitable 150-

ampere hour battery would weigh 300-400 pounds and would need recharging every four days during the dark winter months and every fortnight during the summer. Allowing the requisite number of spare batteries and assuming a works cost of one to two cents per kw hour for an off-peak charging current and a properly organized scheme of motor distribution and collection of cells it should be possible to secure a satisfactory profit by charging consumers 10-15 cents per kw hour (input to cells). Under favorable circumstances a lower rate would be possible, but even 15 cents per kw hour would not be grudged by the majority of medium and better class country residents.

Sons of Jove, Annual Convention.

The annual convention of the Order of the Rejuvenated Sons of Jove will be held this year at Pittsburg, Pa., October 14th, 15th and 16th. Extensive plans are being made by the 10th Jupiter, Robert L. Jaynes for this meeting in his home city, and it is confidently expected that it will be a most successful one.

The candidates for election to the 11th Jupiter are two, both from New York state. Both of the candidates are active Jovians, and men who have done much for the order. They are W. M. Deming of Schenectady, N. Y., and Frank E. Watts of New York City. Mr. Watts has been active and successful as the head of the New York branch of the Jovian order during the past year, and has brought into its membership many men from all branches of the industry. Jovians of New York in presenting Mr. Watts' name feel that he is eminently qualified to head the order, both from his experience and wide acquaintance in the electrical business. From every outlook, therefore, it is quite evident that the coming meeting has features of interest.

Convention of New England Section N. E. L. A.

The fourth annual convention of the New England Section of the National Electric Light Association will be held in Mechanics Building, Boston, Mass., October 15, 16 and 17, 1912. This convention is to be held during the 1912 Boston electric show and in the same building and it is planned to invite the entire membership of the National Electric Light Association. This will give those who could not attend the convention held in Seattle last June a fine opportunity to attend a big convention this year and at the same time visit the electric show. There will be seven interesting papers presented and discussed, besides many other features of interest which are being planned for the visiting delegates.

H. M. Byllesby & Company Assume Management of the Minneapolis General Electric Company.

Active management of the Minneapolis General Electric Company, which was purchased from Stone & Webster sometime ago, was assumed August 1st by H. M. Byllesby & Company, Vice-President Arthur S. Huey personally superintended the transfer. Gen. Geo. H. Harries, for some time president of the Louisville Gas Company, and vice-president of the Consumers' Power Company and of the Minneapolis General Electric Company has been assigned general supervision over the property. Mr. Samuel Kahm took charge as Acting Manager to serve temporarily or until a permanent manager is appointed. Mr. Huey announced that the company would proceed to develop 35,000 hydro-electric power on the St. Croix River above the present 20,000 hp development at Taylor's Falls. He stated also that the company contemplates further water power development on the Mississippi River amounting to approximately 80,000 hp, which would give a total of not less than 160,000 hydro-electric horsepower, including several smaller developments, available to Minneapolis and St. Paul and vicinity. The properties at Minneapolis and St. Paul will be connected by transmission lines and the water powers of the Consumers Power Company at Cannon Falls and Mankato also will be tied in by a transmission line running south from St. Paul. Minneapolis will be headquarters of the Consumers Power Company. The reception of the press and public of Minneapolis to the new management has been favorable.

The Minneapolis General Electric Company, under Stone & Webster's management, has been known as a splendidly constructed and progressively managed central station company. In January, 1912, the company had 16,245 customers with a total connected load of 62,245 hp. There were 429 employes. Business and plant have had great expansion during the past seven years. At the present time the company has installed 22,500 hydro-electric hp and 16,500 steam hp, the latter being in a recently constructed station of the most modern and efficient design. Five thousand additional hydro-electric horsepower will be added to the present development at Taylor's Falls. In spite of the great increase in business during the past few years much additional service can be marketed within a short time. The 1910 census gave Minneapolis a population of 301,408.

Chattanooga Gets 1913 N. E. C. Convention.

Mr. F. H. Cantrell, of the Terrell-Hedges Co., Chattanooga, Tenn., replying to an inquiry, tells how he brought National Electrical Contractors Convention to Chattanooga in 1913.

Editor Southern Electrician:

My trip to Denver, of course, I feel was a very successful one. I left Chattanooga alone with the intention of bringing to Chattanooga the Association meeting for 1913 and at the time I mentioned it in Chattanooga, there were members of our organization that believed it to be impossible to secure it alone and advised me not to make an attempt. However, I took a number of birds'-eye views of the city of Chattanooga from Lookout Mountain, distributed them among the contractors, also a number of post cards of one of our largest power projects, now under construction, namely, the Tennessee lock and dam, also a number of little pamphlets descriptive of Chattanooga. With this material and much persistent effort, I was successful in securing the 1913 convention.

We expect to advertise Chattanooga to the electrical world to such an extent that the 1913 convention will be the largest ever held and we expect further to make it the pleasantest for every visitor. We are now preparing to permanently organize for the purpose of entertaining the people who visit our city in 1913 and make them feel that it is the best trip that they have made either for pleasure or profit.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Better Light and More Business.

Since this is the Annual Lighting Number of Southern Electrician, we feel justified in taking up some space and the time of our readers to consider the effect of light on business, particularly as regards the business of the central station. It is almost a self-evident truth that effective illumination has a stimulating effect on business. There has been a vast change since the days when the sun gave nearly all the light that was needed, when the doors of shops and houses, and the gates of cities as well were shut and barricaded at nightfall, and when to venture out after dark was to do so at great peril. With the development of civilization the hours of daylight have proved too short for the transaction of business and the enjoyment of the social intercourse with fellow men, so that gradually, whether wisely or unwisely, we have been transforming a good share of the darkness into daylight. This effect appears to be cumulative. The transaction of business requires light, for light attracts people, and people by their very presence develop the possibilities for more business.

The display of light for the purpose of attracting people seems to be made most use of by those who cater to the amusement side of human nature, and therefore we find the theaters, the pleasure resorts and amusement parks lavishly, not to say wastefully, lighted, since in these cases the effect produced is simply that of glare, and is not, strictly speaking, useful illumination. However, it well illustrates the attracting power of light.

Turning to utilitarian purposes, we find that in the store, the street, in public buildings, offices, trains, street cars, and wherever men travel or do business, good illumination is of great and essential value. No one desires to travel in a poorly lighted railway coach, or walk along a dark street, or enter a dimly lighted store. The brilliantly lighted streets are therefore most traveled and the well illuminated stores have the largest trade.

Illumination in most cases should not only be sufficient, but it should be ornamental. Lamps, standards, globes and chandeliers should all be attractive. The great increase in the number of ornamental street lighting systems installed during the past two years is largely due to a desire for an ornamental effect rather than from any actual need of light.

With the desire for all kinds of lighting developed into a demand, and since it is now the order of affairs to do business after dark, let us have enough light to see what we are doing without too much effort. Let there be on our streets and in our places of business, not a glare of light, but an attractive and properly diffused lighting. Further, let us see that those who have to work by artificial light are not hampered in their work and subject to eye troubles due to insufficient light. And now someone may ask, what has this to do with new business? Much in every way. Each well lighted building, whether it be a residence, store, church or place of amusement, is not only a source of revenue, but is a standing advertisement for the central station. It seems to be little short of providential that with the astonishingly rapid increase in the demand for artificial light, there should have been developed at nearly the same time light sources which have been almost revolutionary in their effect upon both inside and outside illumination and enabling a great advance in illumination without anything like a proportionate increase in expense. We refer, of course, to the tungsten lamp, and the flaming arc and vapor lamps. Had these not been brought forth at this time, advance in illumination would have been seriously retarded, and that which was achieved would have entailed a heavy expense. Therefore let it be known that better light means more business.

Isolated Plant Competition.

Most of the material written on this subject is from the standpoint of the central station, and the author usually starts out with the assumption that any man who operates a private plant is an ignoramus of the first degree, and then proceed to produce figures in support of his position.

As a matter of fact, there are two sides to the question, and the man who makes his own current in preference to buying it, evidently has some reason for doing so, and when he continues this year after year, in spite of the efforts of central station, it is evident that he thinks it pays him to do so. Further, since we could not off hand pronounce all isolated plant owners as being devoid of understanding, it must follow that a good many have figures to back up their opinions.

Now as a general principle we may safely say that centralization of effort aids in economy of production. A central station ought therefore to be able to supply a consumer as cheaply or more cheaply than he can supply himself. Furthermore, as a general principle, the larger a plant the more continuous and uniform will be its product. That is to say, central station service is, as a rule, more satisfactory than isolated plant service.

However, these general principles cannot be accepted as a proof that every isolated plant is an unprofitable investment, since this is not by any means the case. Let it not be thought that the Editors "have it in" for the central station, or wish to discourage any competition for business served by isolated plants, for their only object in presenting both sides of this question is to encourage the reader to thoroughly and carefully weigh the questions involved and to reach a decision in accordance with the actual facts, and not of a matter of prejudice. Since the central station's argument has been so widely disseminated, may we not be pardoned, therefore, if we dwell on the other side of the question for the important purpose of treating the matter fairly and suggesting pertinent facts that every central station man must consider in competing successfully with the isolated plant.

In the first place the plant owner has no distributing expense or troubles, no transformers or lightning arresters, no poles to decay or wires to blow down. In nearly every case he utilizes the exhaust steam for heating, while his neighbor, the central station, is allowing it to escape to heat the frosty winter air. Since the heat in the exhaust steam is almost as much as the live steam the former makes an enormous saving. Furthermore, the plant owner in general does not have to pay dividends on inflated stock values, or franchises or good will or other things not representing actual investment. Again, the small plant may be and often is run by a man who devotes most of his time to other duties about the building while in large isolated plants the labor cost would not differ much from that in central stations.

On the other hand, we find a great number of small lighting plants running at a considerable greater expense than the cost of central station service. Many of the owners do not know what their plants are costing them. Satisfied with adding up the labor, coal, waste, oil and repairs, they frequently take no account of superintendency, value of space occupied, taxes, insurance nor depreciation. No general rules can be given, but if the central station manager and the plant owner are each willing, as they should be, to submit the question to scientific analysis, it will be possible to solve the question arising in any particular case as to whether the individual plant will or will not pay. Central station solicitors should familiarize themselves with the factors involved, and where there appears to be an advantage in central station service they should be able to present the arguments in a clear and forceful manner. Business of this kind is secured only by a strict application of scientific principles and resolves itself, therefore, largely into a matter of education. A. G. Rakestraw.

Mr. Merrill's Contribution in September Issue.

We desire to thank Mr. G. S. Merrill for his interesting and valuable comments in the September issue on the rate discussion from a commercial standpoint. The interest taken in this subject has been most gratifying and we hope that those who have followed the discussion throughout will find their views on the subject more clear and definite and the thoroughly commercial side of the rate question emphasized.

Commercial Department Organization and Methods.

There is plenty of opportunity for a general discussion on this subject as presented in the September number. The field is large and full of interest, and we will be glad to take up more in detail any subject which may be suggested. Plans for a new series of articles to be discussed during next year will soon be made and suggestions will be most welcome at any time.

Mr. Mateer in his contribution in the September issue, has very cleverly divided commercial energy into three divisions arranged in order of their profitableness. It is true that in many cases present customers are neglected in the rush of hunting up new ones, for the temptation among solicitors to do this is strong. This is because of the fact that time spent in securing additional business from present customers, or in satisfying a kicker and thus preventing loss, cannot readily be shown in figures. The remedy for this lies in securing men of such caliber that they are willing to sacrifice the desire to make a showing for the sake of the best interest of the company, and who will work hard for results even where credit cannot be clearly given. Such men are not easy to get but something of this spirit can be developed among solicitors by appreciative treatment.

SUGGESTIONS FROM READERS.

R. B. Mateer, Manager Agricultural Sales, Great Western Power Co., on Central Station Business and Its Comparative Value.

The question is often discussed as to which business is of the greatest value to a central station, that occasioning an increase in the peak and resulting in a rapid increase in connected load, or that business which does not increase the peak but rather has a tendency to increase the kilowatt-hour output by reason of operation over a greater period of time. In inviting discussion, it is not the intention to antagonize the advocates of one class of business or to urge that it be neglected to the detriment of the central station. Rather is it desired to call attention to that portion of our business which is secured as a result of the daily operation of a motor in some dark, dirty cellar. Such a load operating largely during the day is secured from the motor connected to the elevator or that connected to the rip saw, planer and mortising machine of the mill. Nor should we neglect the motor used to operate the flour and feed mill where many machines operating at one and the same period receive the grain and by successive changes provide the flour so necessary to the household. Railroad shops, as now constructed, contain individual motor operated machines, eliminating the long shafts and belting, so prevalent in early days. Huge blocks of marble are to be sawed and later polished that the office building and home may be ornate. The motor is used to operate the compressor or saw necessary to produce a finished product.

Water must be distributed over large areas and to satisfy the average household must be under certain pressure. In the old days the steam operated pump was used with its great expense occasioned by maintenance and operation. Today the silent running motor, direct connected or belted to the pump, performs the work of the noisy, clanking, steam engine. The huge ash piles formerly common are no longer an eye sore. The smoke so nauseating to the nearby property holder is superseded by the calm, smokeless, easily operated motor. The cinder pile of the past is now a part of the green lawn, rendering the reservoir and its vicinity quite inviting, even to the pleasure seeker.

Water is necessary for irrigation and the farmer who formerly suffered from drought and later endeavored to operate the noisy, jerky, gasoline engine, now throws a switch and the small electric motor pumps from deep down in the earth the ever-refreshing stream which results in abundant crops. No need to watch this unit. As long as the power is supplied from the central station and the lines are in good order, the pump operates without care.

The contractor of the day does not think of renting a noisy, smoky steam hoist or concrete mixer; he supplies himself with a mixer and hoist combined and so arranged

as to operate by means of a motor that may be connected to any line in the city. More concrete is mixed, a more uniform product secured and a better structure the result; and so, many more applications of the motor might be enumerated, each illustrating how the steam or gasoline engine is relegated to the rear and how the central station increases its earnings.

Earnings secured by motor load do not occasion heavy investment expense, nor do they increase the peak; rather do they represent the velvet which every cntral station should obtain. Is not such business profitable and of far greater value to the central station than that which is purely and simply a lighting load, occasioning an increased peak. or a maximum of demand for a short period only?

Under the class of peak business may be included the electric range, which, though advocated by many central stations, yet occasions a period of conflict with the peak. The morning and noon meals may be prepared at an off peak rate, but the evening meal invariably occurs at such a time as to result in the greatly increased peak. Therefore, is it generally considered as valuable to promote the use of such appliances on a uniform rate and irrespective of the time of the day that they are used? Doubtless some advocates of the fireless cookers have a solution such as will aid in overcoming this peak condition. Even so, should a power rate be granted for such business as occurs for a short time period of usage? Is it not better to place business of this character on a combination rate, consisting of a fixed charge, based on the maximum demand and a meter rate sufficient to cover manufacturing and distribution charges?

Again, is it desirable to encourage the use of display or sign lighting operating on a meter basis and resulting in only a short burning period even though the rates per kilowatt are such as to yield a maximum return? Is it not more desirable to insist that business of this character be operated by the use of time switches and under contract requiring at least six hours burning per evening, even though flat rates as generally figured are contrary to the existing schedules?

Again, compare the returns to a company from a motor load and that secured by the use of display lighting and which class of business warrants the maximum expenditures for its development. Consider, if you will, that the motor does its work silently, quickly and with little or no attention over a period of from eight to twenty-four hours per day, returning to the owner increased profits by reason of increased output.

Consider the sign, beautiful at night and for a period of a few hours only, dressed in many colors; while during the day, often unnoticed and somewhat distateful to the eye.

Description of Display Room of Columbia Railway, Gas and Electric Company.

BY E. A. M'COY, NEW BUSINESS MANAGER.

The display room of the Columbia Railway, Gas and Electric Company, is located in the Equitable Arcade Building, at the Washington street entrance. It has a frontage of 20 feet and extends down the Arcade 60 feet, making a total of 1,200 square feet of floor space. Two large plate glass windows, 6 feet by 12 feet each extend

FIG. 1. DISPLAY ROOM OF NEW BUSINESS DEPARTMENT, COLUMBIA RAILWAY, GAS AND ELECTRIC COMPANY, COLUMBIA, S. C.

from the floor to the ceiling, forming the front on the Washington street side, which are seen with drawn curtains in the illustration. Seven plate glass windows form the wall on the Arcade side and three sets of double doors form the entrances and exits to the display room. A series of platforms extend along the wall from the front of the building the entire length of the display room, the platforms being 6 inches high and 30 inches wide, upon which are ranges for display, connected up and ready for demonstration, a large cabinet range being connected at the extreme front, the ranges graduating in size down to the 18 inch double oven stove. All styles of water heaters from the automatic to the coil tank heater are also connected up ready for demonstration.

Down the center of the display room, two large mission tables are seen, especially constructed for demonstration and display purposes. They are 30 inches high, 12 feet long and 4 feet wide, connected for gas and wired for electricity. Any gas appliance or electric device can be demonstrated in a moment's time. Three platforms 6 inches in height, 30 inches in width and 6 feet in length form the display space in the front windows, same being so constructed that they can be taken out at once.

Fixtures are on display of both gas and electric, three large domes covering the two tables and three electric shower fixtures extending down the display room and two large gas arc lamps are hung in the front windows. Nearly every electric device known, especially for domestic and industrial purposes, is displayed and demonstrated. Likewise gas appliances. The effect has been that the sale of these devices has been greatly stimulated in Columbia.

A Card System Showing Status of Customers' Business.

[Mr. McCoy has made up and is making use of a unique card system for his solicitors and to keep an exact record of the status of each customer's connections. In the illustration the nature of the card isshown, No. 1 being the blank card and No. 2 as it appears for a particular customer. Since both gas and electric properties are operated by this company the card is divided, the left side for electrical connections, the right for gas. The card system is used for both business and residental districts and is found

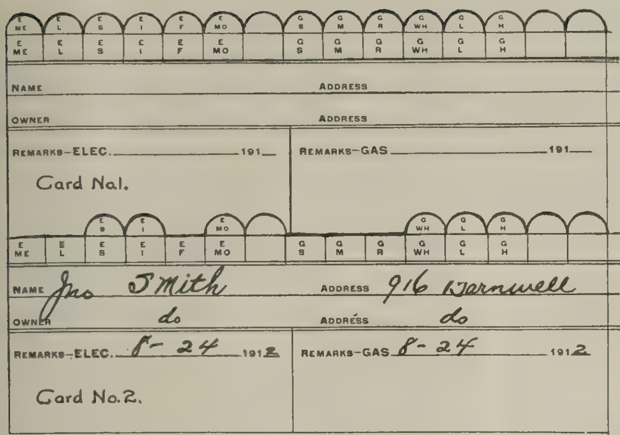


FIG. 2. SOLICITORS' CARD SYSTEM USED BY NEW BUSINESS DEPARTMENT.

simple and practical. Mr. McCoy has a copyright and patents pending on this system. He explains the use of the cards in what follows.—Editor.]

Card 1 or the ordinary plain card is given to the solicitor to go out and get his data. This card is for both gas and electricity or can be used separately for gas or electricity. It will be observed that fifteen projections are arranged at the top of the card, seven of which are devoted to the electric end of the business and eight to the gas. The first projection is marked "E," meaning electric and "M. E." under the E meaning meter. The L on the next projection signifies light, the S, sign and so on, I-iron, F-fan, MO-motor. The blank projection is the miscellaneous one and can be used for any appliance not listed on the other projections. The same rules apply on the opposite side of the card to be used in the gas department.

Card 2 is the card after the Solicitor has secured his data. It will be observed that John Smith, according to this card, has an electric meter, electric lights, an electric fan, and that he is a prospect for an electric sign, electric motor and an electric iron. On the gas side of the card you will observe that he has a gas service, meter and range and that he is a prospect for a gas water heater, gas lights, and a gas heating stove. It is the object of the Solicitor to get all of the projections clipped off of the card. For instance, when he sells John Smith a motor he will clip off the projection marked "E-MO." etc.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

SIZE OF UNITS FOR 25,000 KW CENTRAL STATION.

Editor Southern Electrician:

(328). In a well developed city of from 40,000 to 60,000 inhabitants where it has become necessary to redesign or install a new steam generating station, what are the conditions that determine the suitable capacity of boilers and generators to take care of the natural increase in future demands upon the plant? What is now considered present practice in the capacity of boiler units with economizers for a turbine plant of 25,000 kw generator capacity? Assume a case giving load curve under average operating conditions and show how to select sizes of units. W. C. D.

HOW DOES DISCHARGE RHEOSTAT OPERATE?

Editor Southern Electrician:

(323). I am sending you a diagram showing the connections of a discharge rheostat which I have on a switchboard. I would like to know the operating principles of this rheostat, as I have never seen one of this type before. The double throw switch is so arranged that in throwing

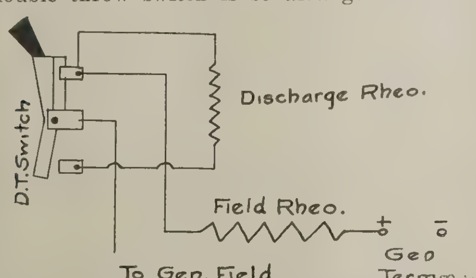


DIAGRAM OF DISCHARGE RHEOSTAT.

it downward the lower contact is made before the top one is broken, which break is made suddenly. The discharge rheostat is 180 ohms resistance, the machine 300 kw, 500 volts.

C. A. H.

COST OF STEEL TOWER TRANSMISSION LINES.

Editor Southern Electrician:

(324). I would like to ask through your question and answer department that some reader give data on the cost of a completed steel tower transmission line of single and double circuit design. I would like such data to include cost of towers, insulators and clamps and the labor necessary to assemble and erect towers and lay foundations. The part of the total cost per installed tower or per mile of line is desired for each item in the construction of lines of over 66,000 volts. If possible data on any special structures should be given separately. G. S. M.

TROUBLE ON TELEPHONE LINE.

Editor Southern Electrician:

(325). We have a 17-mile metallic telephone line of copper clad iron wire, strung five to seven feet below a 17,000-volt, three-phase transmission line on the same poles. The phone line is transposed with rolling transposition at every eighth pole. The phones on each end of this line hum loudly while current is on the high tension line, but a phone connected to this same line about half a mile from one end does not hum. At the place where this phone is located, a local system is installed having eight bridged phones on a party line. This line is strung about three feet below a 2,300-volt, three-phase line.

This party line does not hum enough to be scarcely noticed, but upon closing a switch connecting the two lines together, all phones hum so loudly it is impossible to hear a conversation over them. Also the phone on the long distance line which before connecting the local line did not hum then howls. What is the cause of this condition, and how can it be remedied? T. C. M.

CONDITIONS WHEN HIGH TENSION LINE BREAKS.

Editor Southern Electrician:

(326). On a three-phase, 17,000-volt transmission line, feeding from and into delta connected transformers, one line breaks at a pole and each end falls to ground. In falling a horse is killed and falls across one end of the line pinning a man's leg under the horse but not in contact with the wire. What voltage and current does the man get, if any? The line is fed from transformers on pole No. 1, the line broke at pole No. 3, and the horse fell on the end of the line between poles No. 3 and 4. T. C. M.

FUSES FOR A TWO-PHASE, THREE-WIRE INDUCTION MOTOR.

Editor Southern Electrician:

(327). Why is a larger fuse required in the neutral leg of an induction motor on a two-phase, three-wire system, than is required in the outside wires? H. E. S.

CHART FOR TRANSMISSION LINE CALCULATIONS.

Editor Southern Electrician:

(328). Several charts have been published giving curves for the easy and rapid calculation of alternating current transmission lines. The curves I have in mind are those by Mershon and Herdt, the latter being published in the January 2, 1909, issue of the *Electrical World*. These curves, particularly those by Herdt, are very convenient and are sufficiently accurate for short lines. Since long distance transmission is now very general, calculations for lines of 100,000 volts and 100 miles long are frequently required. These calculations are very laborious and require considerable time even for approximate results. I believe it possible to make up a series of curves which will give all necessary results without requiring excessive calculations in their use. Such curves should include the variations in distance, size of wire, spacing of wires, load, power factor, voltage and frequency and should give maximum power that can be transmitted, line loss and voltage regulation, also charging current if possible.

I am aware of the fact that the preparation of such curves will entail a great deal of labor, but I do not believe the problem presents impossible features. It has occurred to me that you may have among your readers, a man with the necessary mathematical equipment and willingness to do this work. If there be such a man, I am sure he will earn the thanks of many engineers if he will contribute the curves for publication. E. P. Peck.

Trouble With Motor Driving Centrifugal Pump.

Editor Southern Electrician:

In regard to the trouble with the motor direct connected to a centrifugal pump about which I wrote you recently, I have made a test on it and find that it was overloaded. As this motor handled the pump satisfactorily up to the time it was first cut out of service, I was decidedly puzzled to know the cause of this overload. Upon opening the pump, however, I found that the piston blades had originally had two 1½-inch holes bored through them and these holes plugged with babbit and hammered in. For some reason these plugs became loose and dropped out until only one remained. After plugging up these holes again the motor operates with no more trouble. I would like to know why the openings in the blades would cause the pump to overload the motor, as I would think that they would have reduced the load? T. C. Metcalf.

Cost of Installing Underground Power Conductors. Ans. Ques. No. 288.

Editor Southern Electrician:

To give cost data on the installation of underground distribution systems would require considerable space, and without the specific data that T. A. B. refers to in his question it is probable that any such general information would be of little value. On pages 198 to 202 of Handbook No. 17, published by the Standard Underground Cable Co., of Pittsburg, Pa., is given a most complete cost discussion of the details entering into the total cost of underground construction. This material is given in so much detail that it will be of great value to engineers interested in this work. For the benefit of T. A. B., I give here a summary of the cost data as presented in the above reference:

Material cost per duct foot in cents:	
Concrete	2.31
Lumber	1.01
Ducts	5.02
Total	8.34
Labor cost per duct foot in cents:	
Excavations	2.66
Installing concrete and ducts and manholes	2.82
Engineering and inspection	2.47
Total material and labor exclusive of paving	16.29

The cost of conductor can be obtained for any particular work and will depend upon the particular conditions.

R. E. Smith.

Inspection and Tests of Lightning Arresters. Ans. Ques. No. 301.

Editor Southern Electrician:

A general mechanical inspection should be made on all lightning arresters to see that no insulators, resistances, conductors, etc., are broken. When an important arrester is installed, it is well to measure the resistance of the earth connection. The general condition of an electrolytic arrester can be told from the appearance of the arc when the regular charges are given it.

Wire resistances on low equivalent arresters should be inspected and tested for continuity after every lightning storm. The composition rods on graded shunt arresters and other arresters containing them, should have the resistance checked after a discharge. The rods which measure outside of the limits recommended by the manufactures should be replaced. E. P. Peck.

Single vs. Three-Phase Transformers. Ans. Ques. Ques. No. 308.

Editor Southern Electrician:

The following is in reply to question No. 308 in the July issue, to which my attention has been called.

The conditions necessary to decide between the use of three-phase as against single-phase transformers are, that generally speaking, the amount of space required by the three-phase transformer will be about 30 per cent less as regards floor area, than an equivalent capacity of single-phase transformers.

The wiring to and from three-phase transformers is somewhat simpler, in that the connections between phases in the three-phase transformer are made inside of the transformer case, and it is only necessary to bring three leads to the primary and three leads away from the secondary. The three-phase transformer, per kilowatt, is also somewhat lighter than the single-phase. These factors are of importance, principally in large cities where substations are built as small as possible on account of the cost of real estate and restricted space.

As regards the relative cost of using the three-phase as against three-single-phase transformers, the cost per kilowatt of the three-phase transformer will, in general, be about 15 to 20 per cent less than the single phase.

As regards flexibility, the three-phase transformer is not nearly as flexible as three-single-phase transformers, owing to the fact that if one phase of the three-phase transformer burns out, while it is possible to short circuit the primary and secondary of the burned out phase, completely cutting it out, the remaining two phases only represent approximately 57 per cent of the original three-phase capacity, and they can only be so connected providing the primary and secondary were originally delta connected. In this case, the remaining phases would be connected open delta, so that for the same heating as originally experienced, operating with all three elements, the capacity would be decreased in about the percentage shown, owing to the open delta operation. Where three-single-phase transformers are used, without any great additional expense, a spare transformer can be kept in stock, so that in case of failure of any one of the transformers, the spare transformer can be cut in.

In case of high voltage transformers, or transformers involving very large capacity, it is often desirable to install the three single-phase elements in separate compartments, thereby securing complete isolation, so that if one transformer completely failed, the other two would be protected. Although there is considerable likelihood that the protection provided between phases in a three-phase transformer would prove sufficient to prevent damage to the other two phases in case of failure of one, the factor of safety against this is much higher in the case of the transformers with each phase in a separate tank. Where oil-cooled transformers are used, it is very likely that the failure of one phase will damage the oil to such an extent that the remaining phases cannot be used until the oil is filtered or new oil placed in the transformer, and in any case, while repairs are going on, all three elements of the transformer are out of commission.

The reason that 25-cycle transformers cost more than 60-cycle of the same rating is that fundamentally the operation of a transformer is the transfer of electrical energy from the primary to the secondary through the medium of a magnetic field. In the 25-cycle transformer, the magnetic field reaches a maximum in what might be called a positive direction, and dies away to zero, again growing to a maximum in a negative direction 25 times per second. This occurs in the 60-cycle transformer 60 times per second. A more or less accurate analogy is that of the relative sizes of two water pumps, one running at 25 strokes per second and the other at 60 strokes per second. Obviously if the same quantity of water were required from the two pumps per second, then the 25-stroke pump would have to be approximately 2.4 times the volumetric capacity of the 60-stroke pump. Obviously the cross section of the magnetic circuit must be much greater in the case of the 25-cycle transformer than the 60, consequently the length of conductors will be greater and the amount of material required in the transformer of equivalent capacity at 25 cycles will be much greater than that at 60 cycles, hence the cost of the 25-cycle transformer is greater than that of the 60-cycle.

H. E. BUSSEY.

Proper Meter Connections. Ans. Ques.. No. 310.

Editor Southern Electrician:

Referring to question 310, which you have asked me to reply to, I find it difficult to do more than give general information since the question does not give sufficient data to enable a specific answer.

(*a*) The questioner states that the current coil is in series with the 2,300-volt primary. This is not recommended, but the current coil should be supplied through a current transformer for voltage about 500. The potential ratio is 20: 1 and if there were a 10 : 1 or 50 : 5 current transformer, the reason for the constants given in the question would be apparent. The reading of the meter multiplied by the product of the current and potential transformer ratios, would be the primary watts.

As regards the meter reading, it is necessary to know the make of the meter, or at least the markings under or over the dials, to tell what it should be. Westinghouse meters are marked 10s, 100s, etc., meaning that one division of the dial is 10 kw hrs, 100 kw hrs, etc. General Electric meter dials are marked 10, 100, etc., meaning that one revolution of the hand on the first dial is 10 kw hrs, on the second 100 kw hrs, etc. In these meters the transformer ratios are taken care of in the gear ratios so that no odd constant is necessary.

(*b*) On compound wound generators, the voltmeter should be connected across the main leads and not to the equalizer, as the terminal voltage of a machine is the voltage delivered to the circuit, and hence the voltage which is desired to know.

E. P. PECK.

Insulation of Wires Through Trees. Ans. Ques. No. 312.

Editor Southern Electrician:

In regard to H. T. G.'s inquiry on clearance and insulation of primary wires through trees, I would advise, where possible to get permission, to trim trees of limbs so that there is ample clearance for the wires. When such permission cannot be obtained, the conditions should be explained to the owner and his feelings as to loss of trees

sounded. If he objects to any trimming of trees and the wires are then run through them by the company, the liability of loss is assumed by the company, and the only precaution against such loss is to insulate the wires well. Such insulation should consist of about 3-32-inch rubber insulation covered with a layer of tape and two braids. Often porcelain tubes can be used taped at the ends to prevent sliding on the wire.

H. B. Davis.

Calculating Illumination. Ans. Ques. No. 313.

Editor Southern Electrician:

The point-by-point method of figuring illumination is tedious, especially where there are several light sources in one room. In this case we have a number of tables or curves from which we can obtain the illumination at any point knowing its distance from the lamp, and the number of feet below it. Taking the plane of illumination point by point we calculate the light flux produced by each source singly and add them together, getting a result which would be correct if there was no reflection. In fact the actual value of the illumination, due to reflection from walls and ceiling may be double the calculated.

The other method is entirely empirical. A given light source or sources being installed in a room, with walls and ceilings of a certain tint, the actual illumination is measured by an illuminometer, and its mean value determined. Now if we will divide this mean value by the watts expanded per square foot, we get a value known as the effective lumens per watt. By comparing the results of a large number of such observations, in rooms of different sizes, and with different kinds of wall and ceiling and with various sources of light, we can arrive at a pretty good idea of what we may expect under certain conditions. The best results that I have seen up to date are expressed in the following table in which tungsten lamps with Holophane reflectors are indicated:

KIND OF REFLECTOR	CEILING	WALLS	LUMENS PER WATT
Clear	Light	Light	5.0
Clear	Light	Dark	4.0
Clear	Dark	Dark	3.4
Enamel or satin finish	Light	Light	4.3
Enamel or satin finish	Light	Dark	3.4
Enamel or satin finish	Dark	Dark	2.8

Of course with no reflectors the difference between the various tints of wall and ceiling would be much greater.

This table is used as follows: If we have a room 10 x 20 feet, to be lighted with tungsten lamps and clear reflectors, and the ceiling is light but the walls dark, we will have to expend ¼ watt per square foot for every foot candle of illumination desired. If we should want an average of two foot-candles, we would require ½ watts per square foot or 100 watts total. We could then use one 100-watt or three 40-watt or two 60-watt or four 25-watt lamps, as our taste and judgment would suggest.

will increase the price. A. G. Rakestraw.

Calculating Illumination. Ans. Ques. No. 313.

Editor Southern Electrician:

In regard to the accuracy and use of the point to point method of calculating illumination as against the flux of light method, it is safe to say that there is much merit in each method and there are certain conditions under which both may be relied upon, and still other conditions where one is necessary to check the other or an average of the two results taken. At best both methods are only approximations, and successful results when using either depends largely upon the experience of the engineer.

The point to point method gives best results for fairly low ceilings, as in industrial plants, offices, stores, etc. For calculating illumination of large areas such as churches, theaters, etc., of irregular shape and height, the flux of light method is more successful. The point by point method has the drawback that reflection cannot be properly determined, so that when a number of lights act upon each other in large spaces too much variation is given on account of the height.

The main objection to the flux of light method is that it does not consider height and gives no idea of uniformity of the illumination. It requires experience to use this method and divide the quantity of light obtained for an area in the most satisfactory way. This method therefore must be supplemented by the point to point method for best results. The formula for use with the flux of light method is as follows:

Lumens required = (area in sq. ft. × intensity in foot-candles) ÷ (per cent lumens effective).

For the point to point method the most useful formula is $Ih = (C.\ P.\ Cos^3\Theta) \div H^2$. Where Ih is the horizontal intensity in foot-candles; C. P. the candle-power of the source; Θ the angle the ray of light makes with the vertical and H the distance of the light source above the plane of reference. This formula requires a curve showing the candle-power distribution at different points below the unit considered.

In reply to the last point of the question the lumens per lamp may be obtained from the following formula, which is approximate for practical work:

Lumens per lamp = Horizontal candle-power × 12.56 × C. For tungsten lamps C (spherical reduction factor) can be taken as .78, for carbon lamps at .82. Knowing the total lumens represented by the lighting units, the total effective lumens reaching the plane of illumination will depend upon the color and character of walls and ceilings and the type of reflector used. The percentage of effective lumens, therefore, for these conditions can be secured from the following table:

Table I. Per Cent of Lumens Effective.

	Ceilings	Light	Light	Medium	Dark
	Walls	Light	Medium	Dark	Dark
Reflector	Prismatic	60	53	45	40
	Steel	48	46	44	44
	Indirect	31	28	17	10
	Opal	50	45	40	37
	Bare Lamp.......	41	35	25	21

H. F. Boyle.

Why Cost of 2200-Volt Motors More Than 550. Ans. Ques. No. 314.

There should not be a great deal of difference in cost, at least not in the larger sizes. What difference exists is no doubt due to the greater amount and the better quality of insulation required for the higher voltage. In some

cases the greater space required for insulation will require larger slots in the punchings to accommodate the wires, necessitating perhaps a machine a little larger and heavier all around. The greater separation required for parts of opposite polarity may also call for some changes which will increase the price. A. G. RAKESTRAW.

Size of Poles for Distribution Systems...Ans. Ques. No. 315.

Editor Southern Electrician:

A reply to question 315 by E. C. T. in the August issue depends more upon the experience of the superintendent of line construction in connection with the kinds of poles used than upon any formula. However, it is usually found that service drops are on an average not more than 75 feet in length in towns and cities. They may in most cases hang with more sag than main line wires with an unbalanced pull sideways on the pole that can be taken at about 300 pounds. Where service drops are made at a height of 30 feet a formula for determining the size of pole required at the ground line is as follows:

$$(d)^3 = (32 \ PL)/(3.14 \ S)$$

Where P is the unbalanced sidewise pull, in this case 300 pounds; L the distance in inches above ground where service drops are taken off; and S the strain at which the pole can be safely worked which can be taken for this case at 800 pounds per square inch. Thus the formula reduces to,

$$(d)^3 = .0127 \ PL.$$

Assuming a case as stated where one service drop is taken off at a distance of 30 feet from the ground,

$$(d)^3 = .0127 \times 300 \times 360$$

$$d = 11 \text{ inches.}$$

This is about the size of a cedar pole with a six-inch top. This size of pole is not to be considered safe when more than two service drops are likely to be taken from it and in such cases a cedar pole with at least a seven-inch top should be selected. As a rule it is desirable to use poles of less than 30 feet where primary lines are carried, thus the formula given will be a good guide when used with proper judgment. H. L. WILLIAMSON.

Banking Transformers. Ans. Ques. No. 317.

Editor Southern Electrician:

Referring to question 317 in the September issue, it is not advisable to "bank" transformers in the sense of installing them all in one locality unless the load is also concentrated there, and in that case a few large ones would be cheaper and more efficient. However, they may all be connected in parallel (each phase separately) irrespective of capacity if they have the same ratio. This arrangement has the advantage that if a certain transformer happens to be lightly loaded it will take some of the load of the heavily loaded ones, the amount taken depending on the resistance (impedance) of the connecting lines, the relative regulation of the transformers, etc.

In any case the capacity of a transformer should be determined by the load in its immediate locality, the general layout being such that the distance traveled by the secondary current should be as short as possible. If the cut-ins are scattered over a large area, it is likely that the cost of the connecting bus would be greater than its utility would warrant.

Natural Frequency of a Transmission Line. Ans. Ques. No. 319.

If a charged condenser be short circuited by a coil containing resistance and inductance the discharge will be alternating (unless the resistance is rather high) and the frequency of alternation is, $N = \frac{1}{2} \pi\sqrt{CL}$, where C is the capacity of condenser and L is the inductance. N is the natural frequency of the system, and if an alternating E. M. F. of frequency N should be impressed on the condenser and coil in series there would be resonance and a destructive voltage across each, which would be much greater than the impressed E. M. F.

Since a transmission line has both capacity and impedance, it will also have a natural frequency, but due to the fact that they are both distributed along the line, the equation will be different from that just given. Dr. Steinmetz gives the natural frequency of a line grounded at one end as, $N = 1/4\sqrt{LC}$. (Transient Phenomena, page 323). This frequency has no relation to the generator frequency and for short lines is much higher.

Series Arc vs. Incandescent System. Ans. Ques. No. 320.

Series incandescent lamps can be used with the same transformer, but the writer is of the opinion that the arcs will give the best service if properly adjusted.

Comments on Article, page 334, August Issue.

In reading the August installment of Mr. Peck's interesting series of articles on instrument testing, I note that he gives a method of using three ammeters with two transformers. This is very convenient when there happens to be only two transformers available, but it contains the possibility of a 73 per cent error in the reading of the middle meter. It will be seen from the illustrations that the current through the middle meter is the vector sum of the other two and is either I or $I\sqrt{3}$ according to the relative polarity of the transformers. One transformer should be reversed, if necessary to cause the middle meter to read the lowest value.

Operation of Three-Phase Generator. Ans. Ques. No. 287.

If the new machine referred to in question 287 of the April issue, is supplying the same number of lamps, etc., as the old one, the load on the wheel is necessarily the same, possibly less because of the higher efficiency of the new one.

The simplest way to prevent whipping of the belt is to arrange an idler pulley to run against it in such manner that it can be moved out of the way when not required. The whipping may be due to bad splices or other irregularities in the belt. It is not advisable to connect the generator to any load without a meter in circuit to insure that it be not overloaded. Also it is bad practice to ground it unnecessarily since such practice might cause some other part of the winding to ground also.

Operation of Hydro-Electric Plants. Ans. Ques. No. 299.

An induction generator can be used in the manner described by G. B., but without a complete knowledge of the layout of the system, it is not possible to say definitely which arrangement is best. The induction generator will operate with little attention and without a governor, but since the synchronous motor requires rather more skilled attention than an induction motor it is doubtful if there would be any advantage in such an arrangement. It is simply a question as to whether the induction machine shall be in

the plant and the synchronous one elsewhere or vice versa. In small systems it is perhaps best to install the synchronous motor in the plant and use it to drive the exciter and correct the power factor also, if one is used at all. Generally the power factor of small systems is so poor that the synchronous motor required to correct it and also furnish magnetizing current for an induction generator would be rather large. T. G. Seidell.

Capacity of Six-Phase Rotary vs. Three-Phase. Ans. Ques. No. 321.

Editor Southern Electrician:

The following answers question 321 by F. E. B., in the September issue. Due to the simultaneous operation of a synchronous converter as a motor and as a generator, the field distortion due to the motor action of the converter is largely counteracted by the generator action, so under the proper field excitation, the field strength will remain approximately constant throughout a great range of load. Therefore the armature iron loss will vary only slightly with the load and can be neglected. The variable loss is due almost entirely to the copper loss in the armature winding. The power rating is therefore determined by the armature heating. This rating is always expressed in terms of the rating the same machine would have if used as a direct current generator and the difference in rating is determined by the copper losses in the armature winding inasmuch as the eddy current and hysteresis loss in the armature is very nearly the same in the two cases.

Now since the load current at portions of each revolution feeds directly from the alternating current side without traversing the whole winding, as must be the case with a generator, the effective armature resistance of the converter is less than it is for the same armature used in a generator.

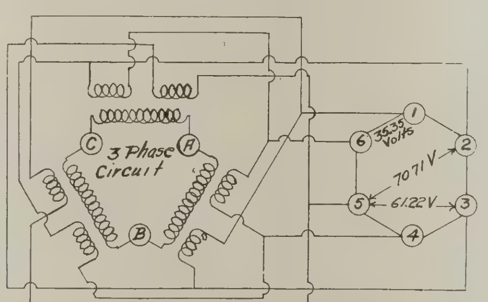


Fig. 1. Connections for three-phase to six-phase with delta primary and secondary.

The ratio of effective armature resistance to its true generator value is as follows: For a three-phase converter 0.56, and for a six-phase converter 0.26. This ratio is then seen to depend upon the number of phases. Let r represent the true armature resistance and R the effective armature resistance. As we have said, the full load rating is to be determined wholly by the heating of the armature, the output current will be greater as a rotary converter than as a generator by the ratio 1 to $\sqrt{r/R}$. Now r/R equals 1/0.56 for three-phase converter and 1/0.26 for a six-phase converter. Therefore the ratio of capacities of the three-phase converter to a generator is $\sqrt{1/0.56} = 1.33$ and this ratio of the six-phase converter is $\sqrt{1/0.26} = 1.958$. Therefore the ratio of the capacity of the six-phase to the three-phase converter will be $1.958/1.33 = 1.47$. This ratio will be reduced if wattless currents are present in the machine.

Since most transmission lines are three-phase, the usual transformer connections are from three-phase to six-phase. There are several ways of making this transformation, but the best is to have the low potential six-phase side connected delta and the high potential side connected delta also. If the voltage of the three-phase side is so high that the successful insulation of the transformer coils become a very important factor, the three-phase line side is frequently connected in star.

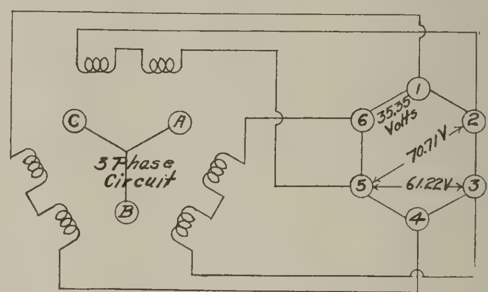


Fig. 2. Connections for three-phase to six-phase with star primary and secondary.

One advantage of connecting delta to delta is that one transformer may be removed from the bank and the service continued without interruption, but the two remaining transformers will have but 58 per cent of the capacity of the original three transformers. W. D. Kellogg.

Natural Frequency of Transmission Lines. Ans. Ques. No. 319.

Editor Southern Electrician:

If we represent a transmission line by a tightly stretched rope, and refer to the familiar phenomenon of a wave or impulse traveling back and forth along the rope when one end is struck, what is meant by the natural frequency of a transmission line will be understood. If, referring to the rope, it be struck on one end as *A*, a wave will travel to the other end *B*, and will travel backwards in a reversed position till it is again at *A*, repeating its journey, but with decreased amplitude. The same thing happens in a transmission line, the period depending upon the length and static capacity of the line.

Now if the impulse has returned to the point A, as shown and at this instant another impulse be given it, in the same direction, it will add its effect to the impulse already existing and produce a greater wave. It is well known how a heavy body can be set in violent vibration by a small impulse repeated at just the right instant. Likewise if a transmission line should be of just such a length that it required the time of just one-half a cycle (or 1/120 second for 60-cycle current) for the impulse to traverse its length, and another ½ cycle to return, it would receive successive impulses at just the right instant to set the line into violent electrical vibration, producing excessive strains on the insulation and possibly damage to the apparatus connected therewith. This is called surging. The remedy is to change the capacity in some way so as to change the natural frequency.

New Apparatus and Appliances.

New D and W Fused Switch Boxes.

To meet the demand for an improved, combined switch and fuse box, the D. and W. Fuse Company has designed a new line of fused switch boxes for 250 volt D. C. circuits. These boxes are particularly adapted for mill service since they may be permanently locked after the fuses are installed, thereby preventing any tampering with the connections or increasing the capacity of the fuses. At the same time, they can be used as a switch since the circuit can be opened or closed at will by simply moving the lever at the side of the box. By referring to the illustration it will be seen that when the cover is opened the circuit is likewise opened, which makes it impossible to re-fuse the circuit when the switch is closed.

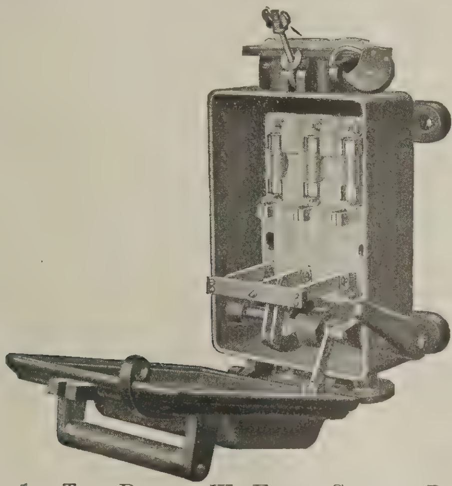


FIG. 1. THE D. AND W. FUSED SWITCH BOX.

The boxes are provided with rubber gaskets which render them positively water-proof provided that the terminal wires are taped in at the bushings or protected by outlet hoods when conduit connections are made. To facilitate installing these boxes removable porcelain bushings are used through which the cable terminals may be readily passed.

Hopkins Electric Tachometer.

An interesting and very successful tachometer which is being marketed by the Electric Speedometer Company, Washington, D. C., is the Hopkins Electric Tachometer shown in the illustration here. This tachometer consists of a direct current magneto generator connected by insulated wires to an electric voltmeter which is calibrated in terms of speed of the magneto shaft. The strength of current in the magneto varies directly with the speed actuating the magneto so that correct readings are obtained for all revolutions per minute indicated on the dial. Since the strength of current is actually proportioned with the speed, the scale is uniformly divided in making the instrument just as accurate at one point on the scale as at any other.

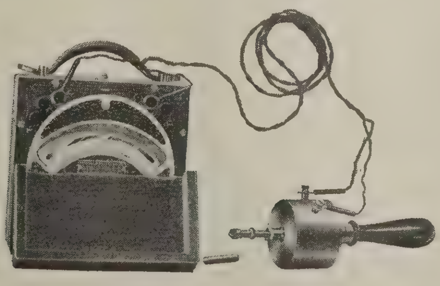


FIG. 1. HOPKINS PORTABLE TACHOMETER.

Since the Hopkins Electric Tachometer operates by electricity the indicating meter can be placed at the most desirable point remote from the shaft whose speed is being measured. For example, a scientific production manager may want to know in his office, the speed of some particularly high class machine located at some point in his factory. The electric tachometer is one which can satisfy service of this character.

This indicator is unaffected by temperature changes since a high grade resistance alloy is used as the greater proportion of the electric circuit. This fact has been proven by the U. S. Bureau of Standards, who have made temperature tests on the system and have certified to their findings. The accuracy of the Hopkins Electric Tachometer is said to be absolute and unchanging. The portable type is guaranteed to be accurate to within ½ of 1 per cent at full scale deflection, while the large stationary type having a switchboard instrument, is guaranteed to be accurate to within 1 per cent at full scale deflection.

Small Direct Connected Generating Sets.

The question of economy opens a wide field for small direct connected generating sets and to meet the demand, it is necessary that the generating set shall not require constant attention, frequent adjustments or numerous repairs. The Engberg's Electric and Mechanical Works of St. Joseph, Michigan, is endeavoring to build such direct connected generating sets for all lines of business, such as all kinds of factory lighting, the lighting of hotels, office buildings, dredges, steam shovels, magnet crane work,

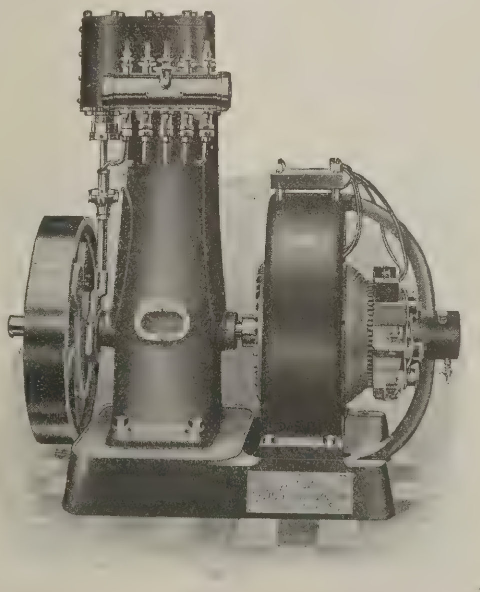


FIG. 1. THE 2½ KW SIZE OF ENGBERG GENERATING SET.

steamboat lighting, etc. All parts of the set are simple in construction and equipped with a carefully designed lubricating system such as to require little attention. The steam engine driving the generator operates under 90 pounds steam pressure and is one that will stand long and hard service.

The accompanying illustration shows the external design of the set as built in sizes from 2½ to 50 kilowatts. The engine is of substantial construction provided with a governor that controls the speed within 2 per cent from no load to full load. The generators are of liberal design, compound wound, the series and shunt coils being separately and form wound. The armature is drum wound and provided with air ducts for good circulation of air. The commutator is sufficiently heavy for wear and built up on a sleeve bolted to the armature drum so that the shaft can be removed without disturbing the windings.

Independent Compound Starting and Regulating Rheostats.

The Independent compound starting and regulating rheostat illustrated in the accompanying cut is a device for properly starting a motor and giving a wide regulation of speed by inserting resistance in the shunt field. In this rheostat which is manufactured by the Independent Electric Manufacturing Company of Milwaukee, Wisconsin, there are two sets of resistance namely the armature resistance and field resistance and two levers employed. The larger or left hand lever is used for starting duty only while the smaller or right hand lever is used to insert resistance in the motor field.

When starting the motor the left hand or starting lever is moved towards the right to the last or running position, at which place it becomes in contact with the no-voltage release magnet, the attraction of which holds this lever in its running position. The spring at the hub of the lever prevents it being left in any except the running or off position. When the starting lever is in its running position the right hand or field resistance lever is automatically released and free to move towards the right. This lever, however, cannot be moved until the starting lever is in its running position, By moving the field lever to the right, across the contacts, resistance is inserted weakening the motor field until the desired speed is attained.

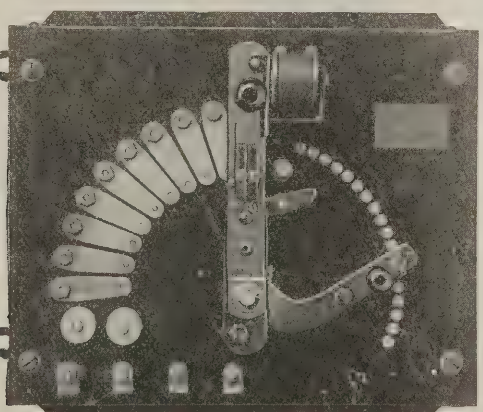


FIG. 1. STARTING AND REGULATING RHEOSTAT.

The two levers are mechanically and positively connected so that when the starting lever is at the off position the field lever must always be at the extreme left or on the first button where it is locked and remains locked until the starting lever is in its running position and held in place by the release magnet.

Should the voltage at any time fail while the motor is in operation, the release magnet releases the starting lever and the hub spring in the lever causes it to fly back to the off position and in doing so on account of the mechanical conection between the two levers, it carries the field lever also to the first button where it is automatically locked and cannot be moved again until the starting lever is on the running position. With this device it can be readily seen that during the starting of the motor and bringing it up to its normal speed the full field current necessarily is in use and no short circuiting switch is necessary to put the maximum field current in while starting.

Progress in Lighting Fixture Design.

The excellent educational work that the Illuminating Engineering Society and the various technical publications throughout the country have been doing in scientific illumination, has awakened the public to the urgent need of not only more light but light of such a quality as to be condusive to the conservation of vision. The advent of the tungsten lamp with its high intrinsic brilliancy and its gradual adoption to common use has made necessary the lighting auxiliaries such as shades and reflectors which today appear in innumerable shapes and forms. However, the field for originality is by no means exhausted as is evidenced by the fact that new shapes and designs with

FIG. 1. A NEW SEMI-INDIRECT LIGHTING UNIT.

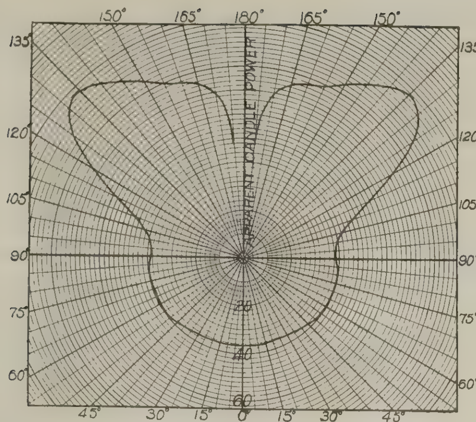


Fig. 2. Photometric Curve for Unit in Fig. 1.

some feature of improvement are constantly being brought out making the ideal of perfection of yesterday obsolete.

The various systems of indirect and semi-indirect lighting are gradually gaining favor with the public which, aside from the intrinsic value of this class of illumination in itself, is due perhaps in part to the numerous ill designed systems of direct illumination with the accompanying glare from exposed lamps of high candle power, and the public's gradual awakening to the lasting detrimental effect on vision. Owing to this increasing tendency toward some form of indirect illumination, the activity of the designer probably has been directed more to the type of unit which will produce satisfactorily and efficiently this kind of illumination.

Figure 1 shows a new creation of the fixture designer in the form of a semi-indirect lighting unit which recommends itself to innumerable places on account of its high efficiency, moderate first cost and ease of maintenance. The last item is of no small importance since one of the inheritant objections of the indirect and semi-indirect unit is its tendency to act as a dirt collector. With this unit the reflector may be removed for purposes of cleaning without disturbance to the lamp.

In Figure 2 is shown a photometric curve of the light distribution of the unit when equipped with a Haskins Lucida diffusing reflector and a 100 watt clear bulb mazda or tungsten lamp. Approximately 30% of the total lumens of the lamp are transmitted into the lower hemisphere as direct light, the remaining light being reflected upward to the ceiling to be again reflected down into the working plane.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

ALTOONA. The city will soon vote on a bond issue for a general electric light plant and water works system.

HUNTSVILLE. Huntsville will soon receive electrical energy transmitted from the power plant on the Little River operated by the Alabama Power & Development Co., of Huntsville. The company has recently made arrangements to purchase the Huntsville Light & Power Co., and further plans to construct an electric railway from Decatur to Huntsville as well as string transmission lines to other Alabama and Tennessee towns.

MOBILE. It is reported that the Mobile Electric Co., is planning to install equipment which will double the present output. The improvements will cost approximately $5,000.

MONTGOMERY. President Taft has vetoed the bill giving the Alabama Power Co. the right to build the dam across the Coosa River 7 miles across Wetumcka, Ala.

OKEECHOBEE. The construction of an electric light plant and ice plant is under consideration by Austin & Wright.

TUSKEEGEE. Plans have been prepared by Walter T. Frantz for an electric light at the Tuskegee Institute.

FLORIDA.

BROOKSVILLE. The Brooksville Light & Power Co., has recently been organized to take over the Brooksville Light and Water Works.

EAN GALLIE. A franchise has been granted to the India River & Light Works Co., to supply electricity for lighting the streets and residences.

JACKSONVILLE. It is understood that plans have been adopted for post lighting to replace the present arc system in Jacksonville. Plans are being prepared under the direction of E. M. Markham, Consulting Engineer of the city. The Jacksonville Traction Co. has agreed to furnish poles on Howell street, occupied by its railway, proposing to use combination trolley and lighting poles 20 feet above the sidewalk and of the ornamental design.

KEY WEST. The Consumers Light & Cold Storage Co. will increase the capacity of its plant to something like 100 tons a day. It is understood that two triplex water pumps with a capacity of 1000 gallons per minute, two electric hoisting cranes with a lifting power of 800 pounds each, and a 125 kw direct connected electric generator will be installed..

WINTER GARDEN. The Winter Garden Light & Water Co. has been incorporated with W. H. Reeves, President, D. McKinnon, Vice-President and A. W. Early, Secretary and Treasurer.

GEORGIA.

ATLANTA. The Central Georgia Transmission Company officially tested out their transmission from the Jackson power plant to the Atlanta substation on Thursday, Sept. 5.

BOLTON. The city will vote on the issue of bonds for the construction of an electric light plant.

DOUGLASVILLE. It is reported that the city will vote on October 3rd to decide upon installing an electric light and power plant.

SAVANNAH. The Savannah Electric Co. is building a new steam generating station and will establish substation.

KENTUCKY.

HODGENVILLE. Plans have been completed by Emmett Smith of Chicago, the establishment of an electric light plant.

HORSE CAVE. A bond issue of $5,000 has been voted by the city for the purpose of constructing an electric light plant.

LOUISVILLE. The company is to be known as the Kentucky Utilities Co., has been incorporated with a capital stock of $2,000,000. The incorporators are W. R. Watson, Chas. J. Ruebling, and Earl Powers, all of Chicago. The company proposes to operate gas, water, and other public utilities.

PINE KNOT. Application for a franchise has been made to establish an electric light plant in Pine Knot by William Cornelius of Willamsburg, Ky., and Daniel Taylor, of Jellico Creek, Tenn.

SHELBYVILLE. The Shelbyville Water & Light Co. has been purchased by the Middlewest Utilities Co., of Chicago, Ill. Improvements are contemplated.

SHELBYVILLE. The Wedgerite Power Co. has been incorporated with a capital stock of $25,000. The company plans to erect a plant for the manufacture of patent explosives. Those interested are Albert Cox, A. J. Dietzmann, and J. T. Armstrong.

LOUISIANA.

LAKE PROVIDENCE. An additional generator and engine will be soon installed in the Municipal Electric Light Plant. Bids are now being received.

MISSISSIPPI.

BILOXI. A new street lighting system for the city is under consideration to cost about $28,000. It is understood that the

present arc light will be discarded and 50 and 60 watt tungsten lamps be erected on the plan of an ornamental system.

BOONEVILLE. The installation of an electric light plant and water works system is being pushed by the business manager.

NORTH CAROLINA.

NASHVILLE. The cty of Nashville is planning to construct an electric light system and has under consideration a bond issue of $15,000.

RANDLEMAN. A new electric light and power plant for the Deep River Mills. A 1000 hp compound condensing engine direct connected to 600 kw generator will be installed. Also boilers, condensers and other electrical apparatus.

SMITHVILLE. It is understood that a contract for the construction of an electric light plant has been awarded to D. C. Cookland of Ashville. The contracts for pole lines and electrical apparatus has been awarded to the National Electrical Supply Co., Washington, D. C.

SOUTH CAROLINA.

COLUMBIA. The Carolina Public Service Co., has been incorporated to purchase and construct electric plants. The capital stock is $2,000,000 and C. S. Campbell will head the company with offices at Columbia.

CEDAR FALLS. Reports state the Cedar Falls Light & Power Co., is to improve and enlarge the hydro-electric plant at Fork Shoals. The wood dam will be replaced by a masonry one and the power station will be enlarged about 500 hp. Electrical energy will be furnished to the Katrine Mfg. Co. at Fork Shoals; to Fountain Inn, Simpsonville, and other South Carolina cities nearby. B. E. Geer, of Greenvlle, S. C., is in charge of the Cedar Falls Company.

TENNESSEE.

CURYEAR. A municipal electric light and power plant is under consideration. It is understood that this plant wll be of the hydraulic type.

JOHNSON CITY. The Tennessee Eastern Hydro-Electric Co., has recently taken over the properties of the Watauga Electric Company and the Johnson City Traction Co., of Johnson City. A new power dam is being built by this company near Greenville.

LENOIR CITY. A contract has been awarded to the Lenoir Light & Power Co. for lighting the streets of the city for a period of ten years. The contract calls for five 100-watt tungsten lamps in the business district and 40-watt tungsten lamps in the residence district.

NASHVILLE. The Scenic Sign Co., of 319 Third Ave., will install machinery for the manufacture of outdoor signs. The manager is A. B. Leech.

TEXAS.

HOUSTON. The Stone & Webster Engineering Corporation is soon to make extensive improvements and enlargements for the Houston Electric Co. A substation will be erected and motors, generators and switchboard costing approximately $40,000. The auxiliary apparatus to be installed will increase the expenditure to about $150,000.

BOOK REVIEWS.

KENT'S MECHANICAL ENGINEER'S POCKET-BOOK, 8TH EDITION. Published by John Wiley and Sons, 43 and 45 East Nineteenth St., New York City. 1461 pages. Bound pocket size in Morocco. Price $5.00 net.

Probably no work has been more thumb-worn by a large number of engineers and others engaged in mechanical work than has the 7th edition of Kent's Handbook. Every man who has used this volume has certain portions of it so marked or otherwise made so indespensible that to part with it even upon the announcement of a revision and enlargement of the work is a matter which is carefully considered. We believe however, that upon careful analysis of the additions made in the 8th edition to Kent's Handbook, that this hesitation will disappear and the work looked upon as a New Kent rather than an addition to the old one, and that soon this New Kent will be held in the same high regard as the edition now so familiar the world around.

The 8th edition has 326 more pages than the 7th and 485 pages of new matter well distributed among the 28 subjects treated. It is not to be supposed that the difference of 150 pages were abandoned from the old text for considerable saving in space was made by resetting tables, etc. The work has been entirely reset and revised throughout, and a new style of type used for all tables, making them more readable than the old. A new chapte ris devoted to Thermoddyamics, and one to Internal Combustion Engines. 46 pages have been added to the chapter on steam engines and turbines, the chapter on steam contains a new 4-page table of the properties of saturated steam based upon the new tables of Marks and Davis. Boilers and chimneys contain 25 pages of new matter and formulae for the relation of efficiency to rate of driving and to air-supply, also data on recent large chimneys of steel, brick and concrete. The subject of Heating and Ventilating has been enlarged to 34 pages and is a condensed treatise on the work. These are only a few of the important changes and additions, every chapter has much new material and the complete work is the very latest on engineering. Engineers who now have the old edition should investigate the new one after which we are sure that what has been said here will be found all too little in the way of credit due.

SYLLABUS OF MATHEMATICS. Compiled by a committee on the teaching of mathematics to students of engineering, of the Society for the Promotion of Engineering Education. Published in cloth by the association. 136 pages. Price 75 cents.

The above work is a carefully prepared synopsis of those fundamental principles and methods of mathematics which is thought to be the minimum mathematical equipment for students of engineering. It consists of 6 parts, a syllabus on algebra, one on plane trigonometry, differential and integral calculus, equations, geometry and on dynamics. In regard to this syllabus, Prof. H. H. Norris, secretary of the Society for the Promotion of Engineering Education and in charge of the department of Electrical Engineering at Cornell University, has the following to say: The members of the Society feel that this report should be of benefit in a number of ways. It should show the teachers of mathematics what are considered the fundamentals for engineering subjects. It should indicate to teachers of engineering the preparation which they may reasonably expect their students to have had. It should be a reference syllabus for students or engineers who wish to systemize their knowledge of mathematics or to look up some fundamental theorem. The circulation of their report is purely an educational matter, the Society has undertaken to circulate it without expectation of any direct benefit. The price of 75 cents prepaid is simply intended to cover bare cost of printing.

PERSONALS.

MR. G. S. MERRILL, Associate Engineer, Engineering Department, National Electric Lamp Association, read a paper on "Electric Rates" before the convention of the Georgia Section of the National Electric Light Association at Tybee, Ga., August 15th.

MR. NORMAN B. HICKOX, manager of the New Busness Dept. of the Muskogee Gas & Electric Co., Muskogee, Oklahoma, has been made manager of the Greenwood Advertising Co., at Knoxville, Tennessee. Mr. Hickox has been at Muskogee during the past three years and during which time that city has gained an enviable reputation as one of the brightest and most thoroughly electrified cities of its size in the country. As to electric signs, Muskogee has more per capita than any other city in the country. Practically all power is electrical, and in stores and residence lighting it ranks high. The good standing which the Muskogee Gas and Electric Co. has in its city is due largely to the personality of Mr. Hickox and his exceptional ability to carry out the progressive ideas of the Byllesby organization, the managers and owners of the property. Although yet a young man, Mr. Hickox has shown a combination of executive and commercial ability which is sure to serve him well with the company he is now going with.

Before coming to Muskogee Mr. Hickox was employed to look after new busiess matters for a syndicate headed by Mr. S. S. Bush, of Louisville, Ky. He assumes his new duties August 15th.

MR MIKE S. HART who for a number of years has been responsible for the management of the Consumers Electric Light and Power Co., of New Orleans, La., has recently resigned to become associated with Mr. J. F. Gilchrist, past president of N E L A, in the commercial development of the Middle West Utilities Co. Mr. Hart entered his new field on August 15, and carries with him the best wishes of a large number of Southern friends.

MR. B. H. HAGEDOM who has had charge of the sales work of the Haskins Glass Co. in the South, has been transferred to the company's Chicago branch office where he will act in the capacity of sales manager.

MR. W. P. DAVIS, of 331 West Main St., Louisville, Ky., is now acting as sales agent for the Pure Carbon Company in the Southern States. This company manufactures pure carbon and carbon specialties of all kinds, including tungsten carbon brushes and is located at Wellsville, N. Y.

MR. F. V. L. SMITH has recently moved into larger quarters in the Empire building, Atlanta, his address now being Room 1206. The expansion of his business through taking on a number of new lines and the enthusiasm created by a most successful honeymoon trip through the Northern cities, before which and after, he and his bride were the subjects of glaring newspaper headlines and the target for many old shoes and pounds of rice, has all reacted in such a way as to bring larger business and more of it to "F. V. L." He is now representing in the South the following firms: Safety-Armorite Conduit Co., Thomas and Betts Co., Condit Electrical Mfg. Co., Edwards & Co., and Alphaduct Co.

MR. F. L. DeMARCO, president of the DeMarco-Fulfort Co., Engineers and Sales Agents of Atlanta, has recently returned from a business trip in Northern cities. He payed a visit to the factory of the Ridgway Dynamo and Engine Co., at Ridgway, Pa., for which company he has recently been appointed Southern representative.

MR. R. B. MATEER has recently resigned his position as consulting electrical engineer for the Denver Gas and Electric Light Co., to accept the position of manager of Agricultural Sales for the Great Western Power Co., of San Francisco, Cal. His new address is in care of the company at 233 Post street.

WALTER B. SNOW, 170 Summer Street, Boston, Mass., has published a small booklet devoted to "Publicity Engineering," which is defined as the combination of practical engineering and advertising experience for the creation of productive publicity regarding technical matters. The booklet is written in an interesting style and takes up in detail the scope and character of the service rendered by Mr. Snow's organization.

INDUSTRIAL ITEMS.

THE AMERICAN CARBON AND BATTERY CO., of 500 Olive St., St. Louis, Mo., announce to all its customers, dealers and users of carbon products that the carbon plant destroyed by fire Dec. 27, 1911, has now been replaced by a building and machinery on a larger scale. The entire plant is now in full operation and the following carbon products manufactured: carbon electrodes, carbon and graphite specialties, wet and dry batteries, flash light batteries, lubricating graphite and foundry facngs, all of which can now be furnished promptly.

THE COMMERCIAL BUREAU COMPANY of 50 Church Street, New York City, and known as the manufacturers library, has organized a foreign Commercial Bureau which is sending to all American Consulates a card catalogue file showing American manufacturers in all industries. Once each month in pursuance of this system, the above Bureau sends to the consular offices the new cards received from its subscribers together with additions or alterations made in those previously filed. This data gives the consuls information to use for furtherance of American trade. To place in the hands of the buyer the actual catalogue, branch offices of the Bureau are being established in the principal cities of South America, Africa, Asia and Australia, which points will act as distributing stations for the Bureau, and n which catalogues may be examined by any buyer requesting them.

The Bureau estimates that upon the completion of its system it will be in a position to place the American manufacturer in direct touch with at least 10.000 buyers from all parts of the world, all these buyers to be actual prospects, each to have a credit standing and concerning whom information will be supplied. When it is considered that the personal touch is had with a genuine list of buyers and that the expense of distribution of catalogues, correspondence, etc., is eliminated, the small cost to the manufacturer of the use of the system installed by the Foreign Commercial Bureau as compared with the present expense, is almost negligible. The American manufacturer, whether he be large or small, can at once receive the benefits of the plan and take an active part in the much-desired extension of foreign trade.

THE ATLANTA AND MACON RAILWAY COMPANY has practically completed its plans and surveys and intends in the near future to start construction on its proposed high speed, third rail, electric road, between Atlanta and Macon, a distance of 88 1-2 miles, via Jonesboro, Griffin and Forsythe. C. G. Young, Bankers' Trust Building, New York has been appointed Consulting Engineer representing the interests financing the railway. Mr. Young recently appeared before the Georgia Railroad Commission in reference to the proposed issue of securities.

PASS AND SEYMOUR, INC., of Solvay, N. Y., is distributing a new catalogue No. 20. This publication gives complete information on the new line of Surlock Sockets as well as on outlet box receptacles and rosettes.

THE FAIRMOUNT ELECTRIC AND MFG. CO., of Philadelphia, Pa., has issued bulletin No. 29B describing the Maxum grounding box. This device consists of a hollow cylindrical cast iron shell with a number of longitudinal ribs that extend radially outward from the circumference of the cylindrical surface. Connection to the ground box is made by a galvanized iron pipe screwed into the top of casing and securely fastened. The bulletin gives full description and illustrations.

MATHIAS KLEIN AND SONS, Chicago, Ill., will exhibit the Klein electrician's and lineman's tools in connection with the exhibt of the Western Electrc Company at the Amercan Electric Railway Manufacturers Association convention, held at the International Amphitheatre, Union Stock Yards, Chicago, Ill., October 7 to 12.

MACHEN & MAYER ELECTRICAL MFG. COMPANY, of Philadelphia, Pa., removed on September 1st. to their new building at 21st. Street and Fairmount Ave. affording twice their former space and where their manufacturing plant is laid out on a strict scientific basis insuring prompt and accurate filling of all orders.

THE WESTERN ELECTRIC COMPANY'S earnings continue to run strikingly close to the forecast of the showing for this year made soon after the new year began. It was then figured that 1912 ought to yield a gross business of something like $67,-000,000. Returns for the eight months ended withe August give an indicated gross business for the year of approximately $68,-000,000. July was about 3 per cent ahead of the same month in 1911 and August was 3 per cent ahead of the corresponding month a year ago. The eight months of the current year are also about 3 per cent ahead of the same period last year. The most interesting feature of the company's business recently has been the tendency of the West to show greater activity. Last winter was severe and as a consequence there was a general slowing down of affairs in the spring and early summer. The weight of the approaching harvest is commencing to make itself felt and consequently there is a greater tendency towards expansive development among those states west of the Mississippi.

New business of the company is greater than the rate of deliveries. On January 1, for instance, unfilled orders on hand totaled $8,000,000 and on September 1, $10,000,000, an increase of 25 per cent. There has been no radical change in the average level of prices for the Western Electric's products recently, yet the company is now realizing a better average margin of profit than a year ago, due chiefly to the many improvements made in both the manufacturing and administrative departments and to careful study of the principles of operating efficiency and economy. Improvements in business has been fairly evenly distributed both n respect to territory and nature of goods shipped. About $750,-000 will be spent in erecting new buildings at Hawthorne this year to take over the company's New York manufacturing business. The additions will be completed in about a year and are in line with the company's policy of concentration of the manufacturng branches at Chicago. Export business during August and the last eight months has shown a relatively greater improvement than the domestic business.

THE ELECTRIC MANUFACTURING CO., of 926-940 Lafayette St., New Orleans, has issued a general catalogue No. 9, devoted to panels, cabinets, service boxes, switch boards, electric signs, theatre equipmnt, knife switches and electric incubators. Numerous illustrations show designs and n connection with these complete descriptions, data, dimensons, etc., are gven. The catalogue contains 60 pages and is printed in attractive style on coated paper tsock.

THE BRYANT ELECTRIC COMPANY and the PERKINS ELECTRIC SWITCH MFG. CO., of Bridgeport, Conn., has issued a new catalogue of wiring devices under date of September, 1912. This catalogue contains 128 pages and lists in a convenient way all the necessary information for ordering and for use of wiring devices. It is claimed that this new catalogue contains over 300 devices brought out since the 1910 catalogue was published, so that those interested will profit by the perusal of a copy which will be sent free upon request.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has issued descriptive Leaflet 2480, covering rules for the selection of machine tool motors and gives some valuable information relative to this subject together with several application views. Descriptive Leaflet No. 3516 also covers machine tool motor applications giving ratings and class of motors which are suitable for various types of machine tools. This is exceedingly interesting information put up in serviceable form. A diagram is also given which shows the relation between the cutting speed in feet per minute and the area of cut in square inches, also the cubic inches of cut per minute.

THE WESTERN ELECTRIC COMPANY announce that the Central of Georga has recently ordered the necessary apparatus for making the third installation of telephone train dispatching equipment within the year. The first section of road to be so equipped extended from Columbus, Georgia to Birmingham, Alabama and the second from Macon to Atlanta, Georgia. For the third installation, practically the same type of equipment as that used in the other two will be furnished. The section of road to be equipped will extend from Macon to Columbus branching off at Fort Valley and going from there to Albany, Georgia, a total distance of approximately 180 miles, The dispatcher will be located at Albany. This leaves only one section of the main line not equipped for telephone train dispatching—the division from Savannah to Macon—but plans are already being made for this installation.

Seventeen way-stations will be equipped with Western Electric No. 102-B selector sets containing the well-known No. 50 type selector. Seventeen siding telephones of the No. 1317-W type will be installed in booths to be built along the right-of-way and every train operated on the division will carry a No. 1330-E portable telephone set which may be connected to the line at any point in case of emergency, thus putting the conductor in

touch immediately with headquarters. The wire and hardware for the pole line are also to be furnished by the Western Electric.

TRADE LITERATURE.

GEM LAMPS. The engineering department of the National Electric Lamp Association, Cleveland, Ohio, has recently issued Bulletin 38 which covers the description and performance of Gem metalized filament lamps, with data on the cost of producing light with them. Copies of this bulletin may be had on request.

VANADIUM STEEL. A booklet has recently come to our notice which should prove of exceedingly great interest to all manufacturers who are watching the development of the Vanadium Steel Industry. The contents are unusually interesting, due to the fact that they are not merely a group of assertions but rather a text book of tests which prove beyond a reasonable doubt that Chrome Vanadium Steel contains valuable properties never before developed in any other steel. It appears that the manufacturers, the United Steel Company, of Canton, Ohio, were the pioneers in the manufacture of Chrome Vanadium Steel and dating from the time of its introduction they have specialized in the manufacture of this material.

POLYPHASE INDUCTION MOTORS. The Mechanical Appliance Co., of Milwaukee, is distributing a new thirty-two page booklet which has just come from the press. This booklet supersedes the former twenty-four page booklet, and describes and illustrates the line of type K induction motors. Additions and developments have made necessary the new and larger booklet.

LIFTING MAGNETS. The Cutler-Hammer Clutch Co. of Milwaukee has just issued two new bulletins, one describing circular type lifting magnets and the other magnetic separators. The 48-page lifting magnet bulletin contains many illustrations showing Cutler-Hammer magnets used for a great variety of purposes, inside and out, under water and in snow storms. Considerable new data and figures are contained and a table giving the particular adaptations of the various sizes from the 18-inch to the 62-inch magnets. The log sheets of the dock superintendent of the Inland Steel Co., showing the record made by two Cutler-Hammer 62-inch magnets unloading 4,000,000 lbs. of pig iron in 10 1-2 hours from the steamer Erwin L. Fisher is reproduced in this bulletin. The magnetic separators described in Bulletin 13000 are for use in cement mills, paper pulp mills, terra cotta plants, or wherever it is desired to continuously remove the magnetic contents from the non-magnetic bulk material.

THE OTTO CYCLE. Under date of June, 1912, the Otto Gas Engine Works, of Philadelphia, Pa., published the first number of their house organ to be known as "The Otto Cycle." This publication is issued monthly and in its present form is 5 x 7 inches with an attractive cover in colors. The contents are devoted to a discussion of internal combustion engines in general and the affairs of the Otto Gas Engine Works, product and sales organization in particular. In the three issues already out, much interesting material has appeared and the little publication should receive a ready welcome by all interested in internal combustion engines when once it has been examined. Copies will be sent gratis to those interested.

POLYPHASE INDUCTION MOTORS. The Mechanical Appliance Company, of Milwaukee, Wis., has recently issued a 32 page booklet devoted to the design and construction of Watson motors, as now built in what is known as type K. The booklet is well arranged and contains complete information and data on operation and application of A. C. motors.

GLOBES AND REFLECTORS. The Nelite Works of General Electric Co., Cleveland, Ohio, has issued two new bulletins, Nos. 54 and 103. Bulletin No. 54 is devoted to inner and outer globes for arc lamps, giving shapes and sizes of many designs, as well as tables showing the number that corresponds with the types of other manufacturers. The globes are marketed under the trade name of "Fostoria Noblac." Bulletin No. 103 is devoted to Holophane-D'Olier Steel reflectors. It takes up in some detail the design, of bowl, parabola, dome and large angle types of reflectors. Over half of the bulletin is devoted to data on reflectors and the lamps recommended for the reflectors.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

Cabinets.

KRANTZ MFG. Co., 160-166 Seventh St., Brooklyn, N. Y. Krantz panelboard cabinets of wood, metal lined, or of steel with or without lined gutters. Approved Aug. 22, 1912.

MUTUAL ELECTRIC & MACHINE CO., Wheeling, W. Va. Standard cabinets. Approved July 31, 1912.

SUPERIOR ELECTRIC MFG. CO., 2416-2418 University Ave., S. E., Minneapolis, Minn. Sheet metal panelboard cabinets slate lined. Approved Aug. 15, 1912.

TRUMBULL ELECTRIC MFG. CO., Plainville, Conn. Cabinets with standard requirements. Approved July 31, 1912.

Insulating Materials.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. A molded, insulating, non-combustible compound of moderate mechanical and dielectric strength, unaffected by oils and very slightly absorptive of moisture. It can be moulded with accuracy and is suitable for use in electric fittings requiring material of above characteristics. Approved July 29, 1912.

Panelboards.

ADAMS ELECTRIC CO., FRANK, 904-914 Pine St., St. Louis, Mo. For 125, 125-250 and 250 volts, 2 and 3-wire with and without branch circuit switches, open link, Edison plug or standard cartridge enclosed fuses. Also metering panels when installed in metering closets or approved cabinets. Approved Aug. 13, 1912.

MUTUAL ELECTRIC AND MACHINE CO., Wheeling, W. Va. 125 and 250 volt, 2 and 3-wire, open link, enclosed cartridge and Edison plug fuses and branch circuit switches up to 15 amperes. Approved July 31, 1912.

SUPERIOR ELECTRIC MFG. CO., 2416-2418 University Ave., S. E., Minneapolis, Minn. 2-wire boards, 125 volts; 3-wire boards, 125-250 volts, with Edison plug cutouts in branch circuits, with or without knife switches in branch circuits and main line. Approved Aug. 15, 1912.

TRUMBULL ELECTRIC MFG. CO., Plainville, Conn. 125 volt, 2 and 3-wire and 250 volt 2-wire, cartridge, link or Edison plug fuses. All types with or without branch circuit switches up to 15 amperes. Approved Aug. 13, 1912.

Rheostats.

CUTLER-HAMMER MFG. C., Milwaukee, Wis. "C & H" self starters consisting of individual and grounded solenoid switches for cutting out the starting resstance.

GENERAL ELECTRIC CO., Schnectady, N. Y. "C R" motor starters, speed controllers, field rheostats, theatre dimmers, battery charging rheostats, resistance units, and drum controllers. Starters approved with circuit breakers for fuses. Drum controllers approved when installed with suitable resistance units. Reports of July 18 and Aug. 29, 1912.

WESTERN ELECTRIC COMPANY, New York City. Same notation as given under General Electric Co.

Switches, Knife.

A. G. ELECTRIC & MFG. CO., P. O. Box 406, Seattle, Wash. 250 and 500 volts, all capacities, with or without standard cartridge enclosed fuse extensions. Standard requirements. Approved August 27, 1912.

SOUTHERN STAMPING AND DIE WORKS, 928 LaFayette St., New Orleans, La. Knife switches, 2 and 3 pole, fused and fuseless, 30 amperes, 250 volts. Standard requirements. Approved July 29, 1912.

TRIO MFG. CO., 2424 Third Ave., Rock Island, Ill. 30, 60, 100, 200 and 300 amperes, 250 volts D. C., 500 volts A. C., 600 volts D. C. or A. C. With or without fuse extensions, 1, 2, 3, and 4 pole. Motor starting switch, 30 amperes, 500 volts, A. C. with fuse extension. Approved Aug. 30, 1912.

Switch Boxes.

GRAVES SWITCH BOX CO., 2190 Stearns Road, S. E., Cleveland, Ohio. Cast iron switch boxes with cast knockout held by a thin edge of solid metal. Made for use with flexible tubing in single, double, three and four gang shallow types. Standard requirements. Approved Aug. 14, 1912.

SOUTHERN ELECTRICIAN

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STATEMENT

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COTTON PUBLISHING COMPANY,
H. N. MACKINTOSH, Business Manager.

Sworn to and subscribed before me this 31st day of September, 1912.
S. C. JOHNSON,
Notary Public, Fulton County, Ga.
My commission expires March 21st, 1915.

CONTENTS:

Better Electrical Construction, and How to Eliminate the Political Inspector.

It has been suggested in behalf of more uniform and thorough inspection of electrical construction in all important cities of the United States, that the Jovian Order champion the cause through a national campaign. This suggestion seems to have been an impulsive one, as there is little to merit its furtherance. This is not the work of a single order, whatever be its purpose; it is the work of all the individuals immediately interested, it matters not whether they be Jovians, Independents, or what not. To wage a war of the kind proposed behind the mask of a single commercial order shunts the responsibility of the issue and defeats its very purpose. Better electrical construction is not to be brought about by any great revival moment; it requires a more strenuous treatment and must be effected by wholesale co-operation by sections for immediate relief. Further, the inspection end of electrical construction is not the all-serious part of present conditions, for the tolerance of cut-throat business in electrical contracting effects equally as serious results. Therefore, before any general action can be made effective, the agencies responsible for the faulty electrical construction must be located and well-developed plans inaugurated for the elemination of these agencies in the particular districts effected. It may be of interest to call attention to some of these.

In the United States there is annually expended for electrical construction about $10,000,000, of which at least $4,000,000 is done by curb-stone wiremen, window trimmers, owners of buildings and men not recognized as electrical contractors. Thus, a little over half, 66 per cent, to be exact, is done by legitimate and capable contractors, and this work secured and done by them under such conditions that their profit is scarcely nothing. The National Electrical Contractors' Association is now well organized and there was born at Association Island, N. Y., in September of this year, and now in the process of organization, a co-operative electrical development association, that will have for its purpose the general improvement of trade conditions. This latter body will represent the interests of the central station, contractor, jobber and manufacturer, and be looked to for aid in developing efficient methods for advancing the interests of all electrical business, including the betterment of the very conditions mentioned here. It is therefore behind the flanks of these organizations that any similar movement should draw up its lines.

The most unsatisfactory conditions in electrical construction work today, as far as inspection is concerned, is to be found in our large cities where municipal inspection bureaus are maintained, the chief of which being dependent upon popular vote for his position. In such cases, it is the rule for this official to spend his time in political agitation rather than devote it to the technical features of his office. To secure effective inspection therefore, it is first necessary to replace or dispose of the political inspector and then remove from the contracting field those tendencies which make toward cheap construction.

The basis for good and safe electrical construction is now definitely set forth in the National Electrical Code and electrical contractors accept it as the standard to which they must work. Yet, many contractors can be found, who, through a weakness of human nature or forced by unfair competition, are daily installing work that will just come

within the requirements of the Code. When an inspector finds any of this work that does not measure up, there is a strenuous objection to changes, even to the point of attempting legal action in its support. This sort of thing causes unnecessary viligance on the part of the inspector and the cause should in some way be removed.

It is not within our province to suggest the details of a cure-all for these conditions, however, there are means by which they can be considerably improved. The municipal inspector could be employed as a result of satisfactorily passing a competitive examination, and not elected. Or, what would be better, the municipal inspector be done away with altogether and the inspection turned over to the Underwriters, a reasonable fee being allowed for each inspection, so as to enable the Underwriters to employ the necessary men to properly handle the inspection.

To relieve conditions in the second case above noted, the contractor could be required to stand an examination satisfactory to the Underwriters, the central station and the city. The satisfactory fulfillment of this examination would then entitle the party to a license to do electrical contracting under the distinct understanding that refusal to correct any construction work as specified by the inspector in charge, would at once cause his license to be revoked. These restrictions will eliminate the incapable and irresponsible contractor and thus strengthen all responsible contracting companies. Then, with all agencies removed that tend to reduce the quality of construction work, the work of the inspector will be more effective and the owner protected against the evils now well known.

It is to the interests of all concerned that any high-handed methods and forced co-operation be at once discouraged and any energy available be turned in the direction of those who are now working for an amicable solution of the problem. The responsible contractor is ready to co-operate if he can be shown that his business will be protected, but he can never be forced to perform the impossible under conditions as they now stand. The cause of better electrical inspection will be materially improved through cutting the political strings of municipal inspection and thus do away with favoritism in the case of certain contractors and second the elimination of the undesirable and irresponsible contractor, will, we believe, supplement this also, as well as raise the standard of electrical construction.

Economy of the Gas Producer.

The federal government has for some time been carrying on investigations to determine the possibility of generating producer gas for power purposes in a commercial way from various mineral fuels. Considerable information along this line has been recently given out in a technical paper on utilization of fuels by gas producers and internal combustion engines. This paper is issued by the Bureau of Mines and gives information that will greatly benefit those interested. It is shown that in many western states low grade coal, lignite and peat can be profitably used by the gas producer when they are even of such character that they cannot be used in boiler furnaces, and will not bear long transportation. It is estimated that on an average such coal when tested in the producer-gas plants will develop two and one-half times the power that it would develop in the ordinary steam-boiler plant. In fact the investigators claim that tests on the low-grade lignite of North Dakota developed as much power when converted into producer gas as did the best West Virginia bituminous coals burned under the steam boiler.

The information presented in the paper shows the gas-producer an important agency of conservation. It is estimated that between 250 and 300 million tons of coal is wasted in mining, at least one-half of which might be saved, and that the low-grade coals, high in sulphur and ash now usually left underground, can be used economically in the gas producer for production of heat, light and power, and should therefore be mined at the same time as the high-grade coal.

Another factor mentioned in the investigations is the practical elimination of the smoke nuisance by the use of the gas producer, a matter of no little importance to many cities where bituminous coals are burned under boiler furnaces. As a smoke preventer the gas producer not only effects a saving of 10 to 15 per cent claimed for smoke preventing devices, but from 50 to 60 per cent, a factor in economy which cannot be overlooked.

An Industrial University at Lomax, Ill.

With the view of securing to all manufacturing interests located at Lomax, Ill., the advantage of being in a position to secure a highly trained class of employes, and to secure for all small industries and generally for the inventors of the United States, an opportunity to develop new manufacturing projects under highly favorable conditions, the Lomax Town Company proposes to establish at Lomax an institution to be called the Industrial University, having for its object the upbuilding of all industrial establishments to be located there.

It is proposed to organize the institution with a board of control composed of highly trained experts in mechanical engineering, electricity, chemistry, advertising and business management, with other branches added as the needs of the institution may develop. It is proposed to give to any inventor, free of charge, if he so desires, such advices as will enable him to make any experiments to demonstrate the value of an idea, together with an opportunity to work out such idea and use, free of charge, exclusive and private apartments, equipped with all facilities for the development of such invention.

The object of the university will be to secure a square deal to the inventor as well as to the investor with conditions looking to the greatest possible development of the new industry when established, and an opportunity to the inventors of the United States to obtain such expert advice and assistance as would be otherwise impossible. From these standpoints, the efforts of the promoters of the university are to be highly commended.

Chicago Gets 1913 N. E. L. A. Convention.

At the meeting of the N. E. L. A. executive committee on October 11, the time and place for holding the 1913 convention of the body came up for discussion. This organization has now grown to such proportions that the selection of a meeting place is a task of no small proportion, since few cities centrally located provide the necessary facilities for both carrying on the business of the convention and accommodating the large attendance. The committee was assisted in its task through President Insull of the Commonwealth Edison Company of Chicago, who advised that his company would be glad to have the association visit Chicago in 1913. This invitation was immediately acted upon, and it was voted that the next convention be held in that city. As to the date of holding the convention it is now probable that the third week in May or the first in June will be selected.

Hydro-Electric System of Appalachian Power Company.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY L. S. GRESHAM, ASST. GENERAL MGR. APPALACHIAN POWER COMPANY.

The Details of Plants Nos. 2 and 4 and the Transmission System.

THE Appalachian Power company, with general headquarters at Bluefield, W. Va., operates an extensive hydro-electric power and transmission system in Virginia and West Virginia, its activities at present extending over Southwest Virginia and Southern West Virginia. The transmision system and properties owned by the company are located in twelve counties in the states above named, having a total land area of 5,322 square miles and a total population of 356,000. The Appalachian Power Company was organized in the spring of 1911 to develop water powers on New River and take over a number of electric properties, railway and water plants. These plants varied in size and physical equipment when purchased and a large expenditure has been necessary to put them in proper condition to take care of the increasing demand made upon them by the growth of the community and the business which is now developing.

The companies taken over by the Appalachian Power company within the past eighteen months include the electric lighting and power systems in the towns of Pulaski, Wytheville, Marion, Graham and Pocahontas in Virginia, and Bluefield, Welch, Keystone, Simmons and Bramwell in West Virginia, together with the electric railway system in Bluefield and the water works system in Welch. In addition to the above properties the company purchased from the Pocahontas, Consolidated Collieries company of Pocahontas, Va., a 4,000-kilowatt steam turbine plant, together with thirteen miles of 13,000-volt transmission lines located in Mercer and McDowell counties, West Virginia. This steam station was operated by the company prior to the completion of its first two developments in order to supply electric energy for the coal mines of the Pocahontas Consolidated Collieries company, together with a number of other coal mines located in the Pocahontas coal field. The station is now used for auxiliary service.

TERRITORY SERVED.

The territory embraced by the Applachian Power system covers a radius of approximately 70 miles, as shown by the accompanying map, Fig. 1. In addition to the town served direct by the company, contracts have already been closed whereby current will be supplied to Roanoke, Saltville and Radford, Virginia. The territory served affords an excellent power market, as it abounds in mineral resources, including the famous Pocahontas coal fields, together with iron, zinc, copper, salt and gypsum mines, glass sand, varieties of clay and other minerals. The availability of water power for use in connection with the development of these properties will undoubtedly stimulate the industrial growth.

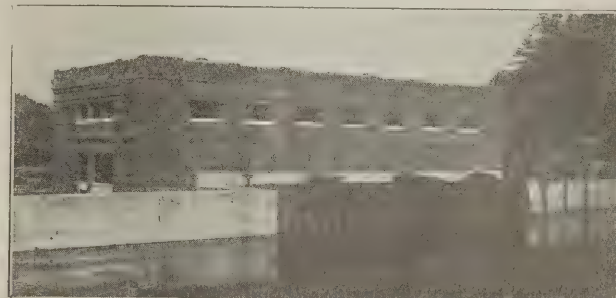


FIG. 2. UP-STREAM SIDE OF NO. 4 POWER HOUSE.

HYDRAULIC FEATURES.

The hydro-electric developments are located on New River in Southwest Virginia, in the counties of Carroll and Pulaski and consist of six separate power sites, known

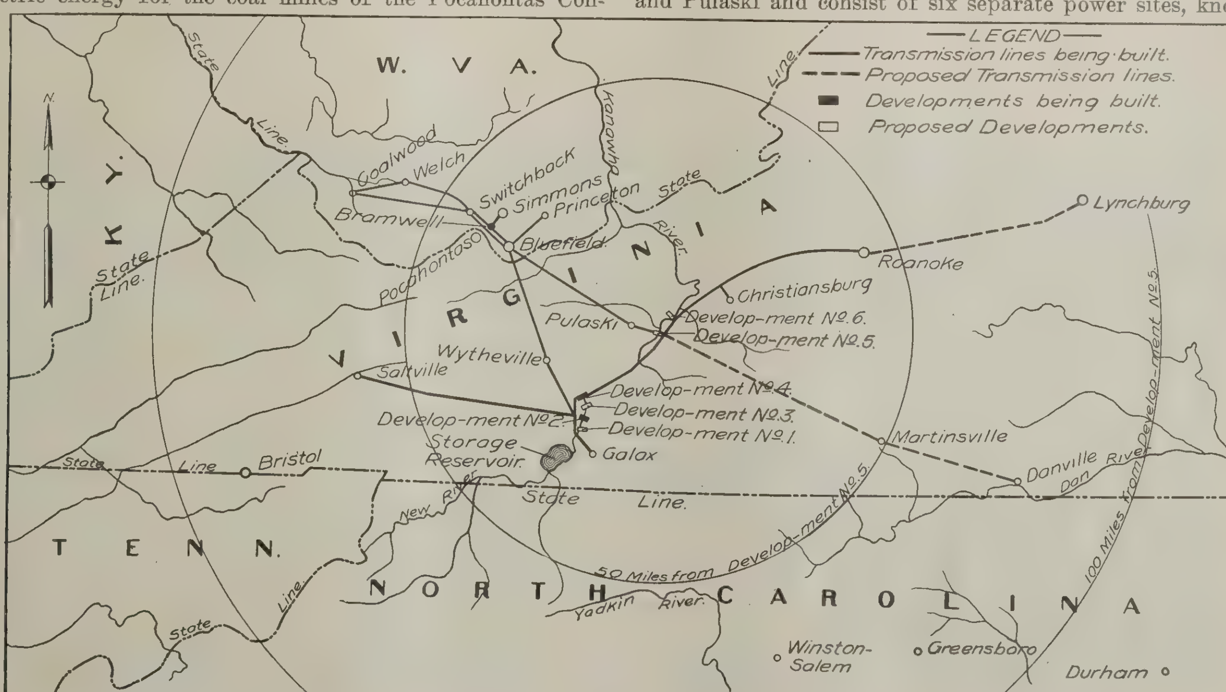


FIG. 1. MAP SHOWING WATER POWERS, HIGH TENSION TRANSMISSION LINES AND TERRITORY SERVED.

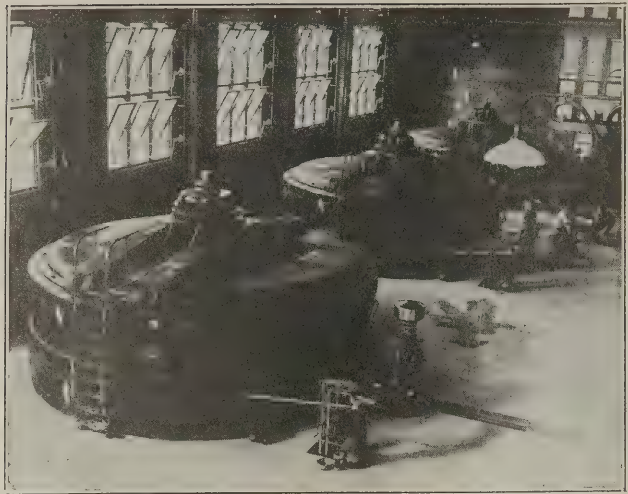


FIG. 3. INTERIOR OF NO. 4 POWER HOUSE SHOWING THREE 2,300 K. V. A. GENERATORS.

as Nos. 1, 2, 3, 4, 5 and 6, aggregating a total head of 225 feet, with a capacity of approximately 90,000-horsepower. It was decided to develop sites No. 2 and No. 4 first, and construction work was commenced on these two developments July, 1911. Owing to a number of future delivery power contracts, it was imperative that the completion of one of the dams should be not later than August 1, 1912.

DEVELOPMENT NO. 4.

Development No. 4 offered an ideal location for the building of a dam, as it is constructed in connection with an island in the middle of the river. The spillway dam is of solid concrete, approximately 1,000 feet in length and 15 feet in height, extending from the south bank of the river across to the island. In order to gain the advantage of an additional head of fifteen feet it was necessary to excavate a tail race sixty feet in width with an average depth of fifteen feet and approximately 1,800 feet in length, from which was removed 70,000 cubic yards of stone.

The power house is located in the southern end of the dam, being 126 feet in length by 39 feet 4 inches in width. The sub-structure is of reinforced concrete while the superstructure is a steel frame with brick walls. A 45-ton electric crane spans the generating room and is available

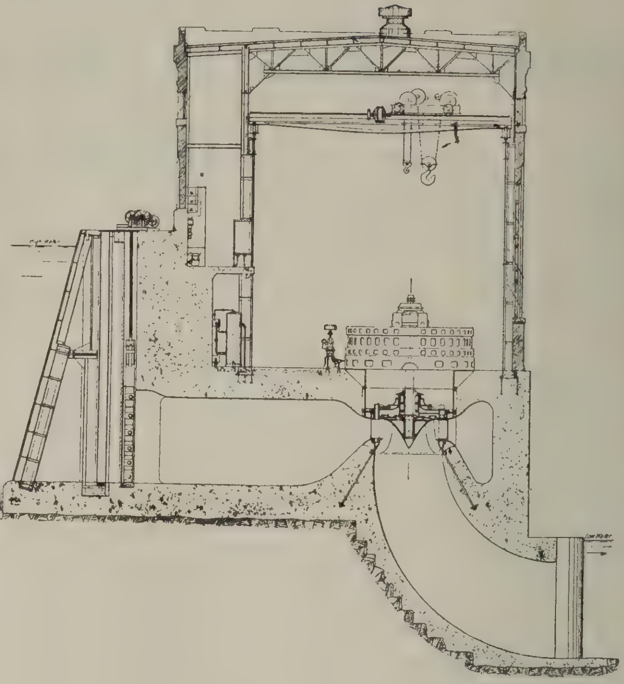


FIG. 5. SECTION THROUGH STATION NO. 4.

for use in handling parts of the turbines or generators.

Tainter gates and flashboards are constructed on the spillway dam so as to gain seven feet additional head and increased pondage during low water. This dam serves to divert the water into a natural head race on the north side of the island at the foot of which the retaining dam and power house are constructed, the head race being about 2,000 feet in length. The retaining dam is also of solid concrete, which closes the channel between the island and the north bank of the river. At the north end are located two sluice gates, each having an opening ten feet by six feet. The bed of the river being of solid rock offered material assistance to the construction work by giving good foundation without much excavation.

THE TURBINES AND GENERATORS.

In the No. 4 power house are three main units each capable of developing 4,500-horsepower with a head of 38 feet and operating at a speed of 97 r. p. m. The turbines are of the single runner, inward discharge, Francis type,

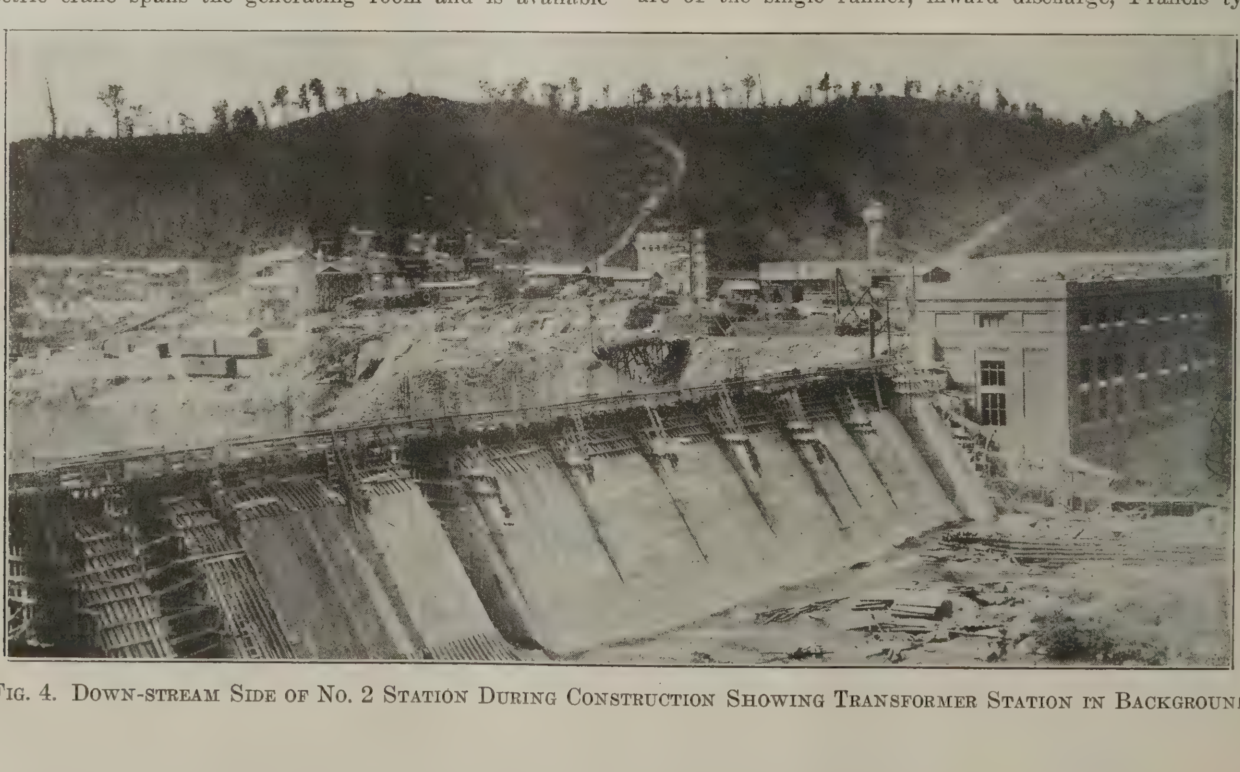


FIG. 4. DOWN-STREAM SIDE OF NO. 2 STATION DURING CONSTRUCTION SHOWING TRANSFORMER STATION IN BACKGROUND.

vertical shaft, the diameter of each runner being 7 feet $6\frac{1}{4}$ inches, while the shaft diameter is $14\frac{1}{2}$ inches. There are also two exciter turbine units, each having a rated capacity of 250-horsepower and operating at a speed of 330 r.p.m., these units being of the same general design as the larger turbines and furnished by the I. P. Morris Company. The governors are of the high pressure, oil type, the oil required for the operation being supplied from electrically operated pumps. From the intake side water can be shut off from each water wheel by structural steel roller gates operated by alternating current motors, each gate having an area of 22 feet 2 inches by 14 feet 6 inches. The water wheels discharge through concrete tubes into a tail race excavated out of solid rock in the river bed.

The generators were furnished by the General Electric Company, and are of the vertical two-bearing type, direct connected to turbine shafts. Each is wound for 13,200 volts, 3-phase, 60-cycle, and delivers normally 2,300 k.v.a.

One interesting feature regarding the separate units in both power houses is that the entire weight of the revolving element is supported by a roller thrust bearing, located at the top of each generator on a bridge spanning the armature. Two guide bearings are also provided for each unit, one located directly under the roller bearing, the other directly above the water wheel; the total weight of revolving element for each unit being 74,000 pounds. The roller thrust bearings were furnished by the Standard Roller Bearing Company.

NO. 2 DEVELOPMENT.

In order to construct No. 2 development it was necessary to move about four miles of the Norfolk & Western Railroad track higher up on the mountain side in order to permit of pondage. This dam is about three miles up-stream from the No. 4 development. There is nothing unusual in its construction from an engineering point of view, inasmuch as it consists of an overflow dam, approximately 50 feet in height and 504 feet in length, and built directly across the river. An auxiliary spillway, built 300 feet above the power house, was constructed by cutting through a ridge for discharging into a natural sluice back of the ridge and by so doing gained 200 feet in the length of the dam.

The power house is a part of and located near the west end of the dam, the substructure being of reinforced concrete, while the superstructure is of steel frame and brick walls. A traveling overhead crane of 45 tons is installed, similar to that in No. 4 power house.

TURBINES AND GENERATORS.

In No. 2 power house there are four 6,000-horsepower vertical shaft water wheels direct connected to 4,000-kilowatt generators, each water wheel unit being of the single runner, vertical Francis type, operating under a head of 52 feet, and at a speed of 116 r. p. m., with the same general characteristics as outlined for No. 4 power house.

The generators, as in No. 4 power house, are wound for 13,200 volts, 3-phase, 60 cycles. Continuous current for excitation is obtained from two 400-horsepower units of the same general characteristics as the larger machines. The governors and structural steel gates are identical to those used in No. 4 power house. Flashboards and tainter gates are placed on the top of the spillway for the purpose of regulating the head.

STEP-UP 88,000 VOLT SUBSTATION.

Both power houses, No. 2 and No. 4, are tied together with a common step-up transformer substation, which is located about 200 yards from No. 2 power house. The building is of modern construction of steel and brick, with the south end left open to take care of future extension. The building is 44 feet 4 inches in width by 88 feet 6 inches in length, with an ultimate length of 122 feet 6 inches.

All incoming lines are provided with electrolytic lightning arresters and remote control oil switches. The switches are mounted in separate concrete compartments, specially provided, opening against the 13,000-volt structure. This structure contains two buses, which are divided into two sections, each so designed that the station load can be taken from any one of the four sections.

Four 6,000 kva, 13,200 volt primary, 88,000 volts secondary transformers are provided for stepping up generator voltage to the line voltage. These units are of the water cooled, oil insulated type, and set in separate brick compartments, mounted on tracks, accessible to an overhead traveling crane. A pit is provided under the crane in which to lower the transformers for repairs. This pit saves overhead space, as the high tension electrolytic lightning arrester equipment is placed directly over the crane on the second floor.

The high tension oil switch equipment consists of the K-15 General Electric remote control type, between transformers and high tension buses and from buses to outgoing lines. The buses are designed so that the load can be

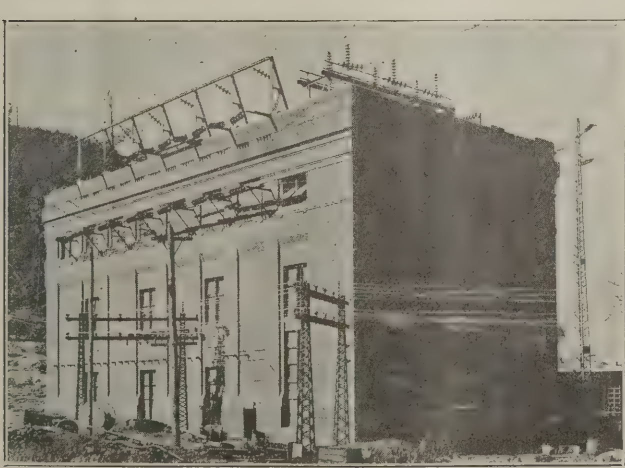


FIG. 6. 88,000-VOLT STEP-UP TRANSFORMER STATION NEAR DEVELOPMENT NO. 2.

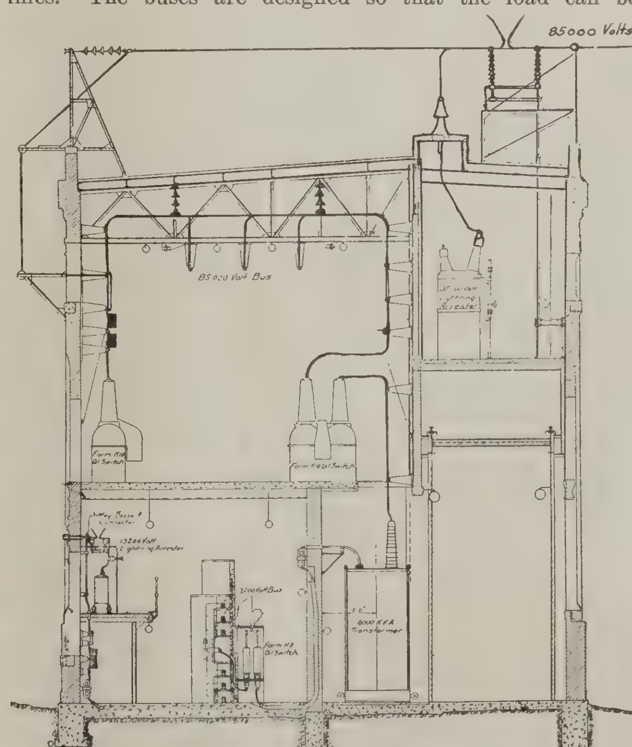


FIG. 7. SECTION OF STEP-UP TRANSFORMER STATION.

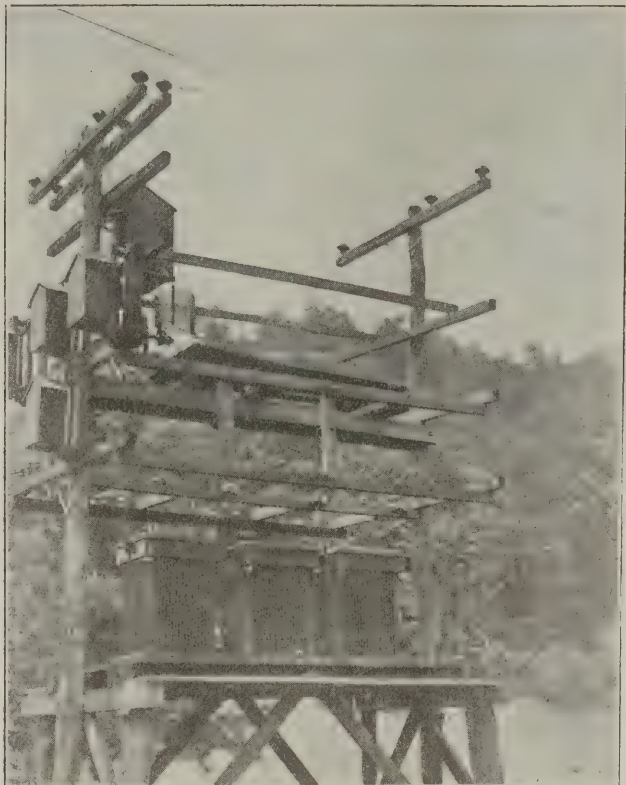


FIG. 8.. TYPICAL 13,000-VOLT TRANSFORMER INSTALLATION.

separated in case of trouble on outgoing high tension circuits.

SWITCHBOARD.

The switchboard equipment at power house and step-up transformer stations is of very simple construction throughout, consisting of standard panels equipped with meters and remote control. All the switchboard equipment was furnished by the General Electric Company.

STEAM RESERVE STATIONS.

A 4,000-kilowatt steam reserve turbine plant is located at Switchback, W. Va., and used as an auxiliary station. This plant is located at the mouth of one of the coal mines of the Pocahontas Consolidated Collieries Company and coal for the operation of the plant is brought direct from the drift mouth of the mine into the boiler plant without handling, which gives a very effective and cheap arrangement for fuel supply. A second steam turbine auxiliary plant is contemplated to be located near the Coalwood, W. Va., substation. This plant will also be located near the drift mouth of some mine in order to minimize the fuel account.

TRANSMMISSION LINES.

All trunk lines operate at 88,000 volts and radiate from the step-up transformer substation. At the present time there are in operation and under construction four separate trunk lines leading from the station, feeding into the Pocahontas coal field, Roanoke and Saltville, Va., with a total of 199 miles. The company also has about 110 miles of 13,000-volt lines, most of which is single circuit on a single pole line. Not counting city distributing systems, there is a total of 309 miles of primary and secondary distribution in operation and under construction.

The transmission line is of the wooden pole type, using 45-foot chestnut poles, eight-inch top, fifteen-inch butt. All poles secured locally. The "Wishbone Type" of cross arm is used on the 88,000-volt lines, with four Thomas No. 1053 insulators in suspension and five in dead end.

Throughout the Pocahontas coal field a secondary distribution of 13,000 volts is used, as this was found to be better adapted to meet local conditions and at the same time tying in with the distributing system taken over from the Pocahontas Consolidated Collieries Company. All low tension distribution is constructed with the "Loop" system, in order to feed either way in case of line trouble. Either three single pole air disconnecting switches or three pole oil switches are placed at each coal mine in order to open up the circuit in case of trouble. All low tension lines are built of standard construction, using Thomas No. 1020 insulators.

Aluminum wire is used throughout the entire system as conditions were favorable to the use of this conductor at the time the system was built. A 3/8 inch standard steel guard wire is located on the extreme top of pole line grounded at every pole.

A great deal of the transmission system extends over isolated and mountainous country, and to keep it thoroughly patrolled is an important duty of the operating department. Lines have been built over mountain ranges which have necessitated every pole hole being blasted out of bed rock. Ox teams were used in order to transport poles along the system and construction work was necessarily slow. In many localities only three to four poles could be set per day.

Private telephone lines parallel the entire system, being installed on the same poles. No. 8 Birmingham BB wire is used exclusively and transposed at every third pole. Telephones are placed at each substation as well as at a good many of the coal mines, in order to communicate with the General Office of Dams in case of trouble. All load despatching is done by telephone direct to and from the main step-up transformer substation.

TRANSFORMER SUBSTATIONS.

There are six step-down transformer substations of modern design and construction, for the distribution of power in the territory served, the substations being located

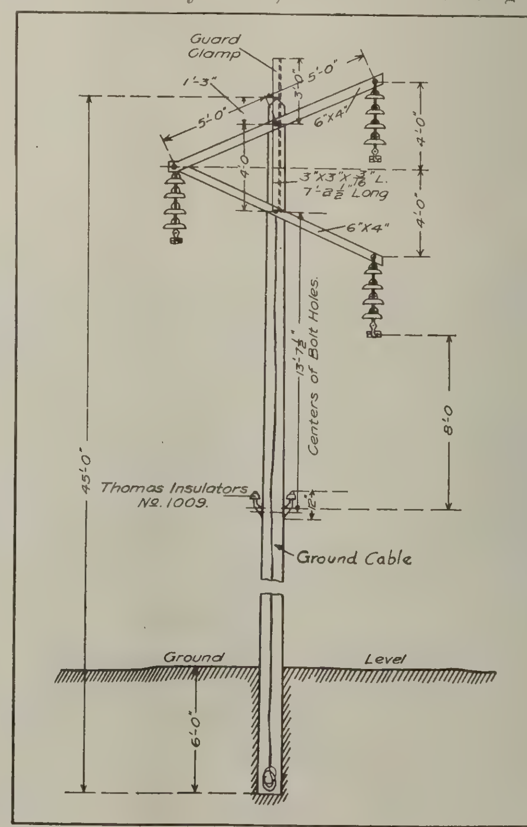


FIG. 9. STANDARD POLE FOR 88,000-VOLT TRANSMISSION LINE.

at Coalwood, Switchback and Bluefield in West Virginia, and Roanoke, Plaski and Saltville in Virginia. These substations range in capacity from 1500 kva to 9000 kva and are equipped with Type K-10 General Electric high tension oil switches, together with electrolytic lightning arresters, the secondary voltage ranging from 2300 to 13,000 volts, depending upon local conditions.

FUTURE DEVELOPMENTS.

As load conditions justify, future developments will be made in order to take care of increased demand. The company employs an experienced industrial agent whose duty it is to keep in touch with all phases of industrial work with a view of locating plants of an industrial nature that will consume power. At the present time a number of such plants are under way. This phase of the business is proving effective and indications point that the company will have to begin a third development in the near future to take care of proposed business.

In addition to the utilities owned and served, as outlined, the company holds a long term contract with the Roanoke Railway & Electric Company of Roanoke, Va., with a maximum demand of approximately 3,000-kilowatt, closing down their present 4,000-kilowatt steam turbine condensing station. A long term contract has also been entered into with the Radford Water Power Company of Radford, Va., with a maximum demand of about 400-kilowatt, supplementing their present small water development on Little River.

A number of coal mines are now being supplied with power in the Pocahontas field of West Virginia for the operation of their entire electrical equipment, consisting primarily of locomotives, cutting machines, fans, tipples and pumps. Alternating current is sold on the low tension side of transformers and if direct current is required, the consumer furnishes the necessary motor-generator set or converters. All inside mine equipment, together with electric haulage, is direct current, while for outside mine purposes, such as fans, tipples, etc., all alternating current is used of either 220 or 440 volts, depending upon local conditions.

At the present time the company is furnishing about 18,000-horsepower connected motor load to coal mines. This business has been secured in competition with individual plants located at each mine, ranging from 100-kilowatt capacity and upward, with coal at $1.00 per ton, or less.

PERSONNEL OF THE APPALACHIAN POWER COMPANY.

The Appalachian Power Company is under the management of H. M. Byllesby & Company, Chicago, operators of extensive gas, railway and electric properties throughout the United States. Viele, Blackwell & Buck, of New York, were consulting engineers in charge of construction of Developments No. 2 and No. 4, and high tension transmission lines and high tension substations. H. H. Byllesby & Company was in charge of the engineering and construction in connection with the various electric plants purchased and the low tension substations, together with the distributing system throughout the territory.

The offices of the Appalachian Power Company are as follows: Mr. H. M. Byllesby, Chicago, president; Mr. R. J. Graf, Chicago, secretary and treasurer; Mr. H. W. Fuller, Bluefield, W. Va., vice-president and general manager; Mr. L. G. Gresham, Bluefield, W. Va., assistant general manager, in charge of New Business Department.

Instrument Testing Methods and Equipment for Central Stations.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

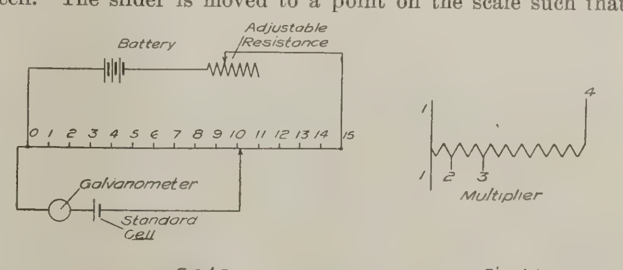
BY E. P. PECK,
ASST. ELECTRICAL ENGINEER, GEORGIA RAILWAY AND POWER COMPANY.

The Potentiometer, Its Use in Checking Ammeters and Voltmeters—Some Miscellaneous Measurements With Portable Meters—Phasing In.

THE potentiometer was mentioned, and a simplified diagram was given in the first article of this series. It seems now advisable to give a somewhat complete description of the instrument and its uses. The potentiometer measures only D. C. voltages of low values, but with suitable accessories it may be used to measure voltages up to very high limits, currents of almost any value, and resistances over a wide range.

In principle the potentiometer is very simple and may be represented by a small resistance wire stretched over a graduated scale, with a contact making slider. In addition a battery, an adjustable resistance in series with the battery, a galvanometer, and a standard cell are necessary. Fig. 1 shows the arrangement of the apparatus.

To adjust the potentiometer for use, a current must be passed through the slide wire and the current value adjusted so that the voltage drop over the slide wire agrees with the figures marked on the scale. This adjustment is determined by the standard cell and galvanometer, the standard cell voltage being certified by its makers. The slider on the slide wire is set on the number corresponding to the certified voltage of the standard cell, and the adjustable resistance adjusted so that there is no deflection of the galvanometer moving system. There is now no current flowing from or into the standard cell, so necessarily the voltage drop on the slide wire between zero and the slider is the same as the voltage of the standard cell. Therefore, the slide wire has a drop in volts which agrees with the figures on the scale. That is, if the pointer is set at 1.00, the voltage drop from zero to 1.00 is 1.00 volt. The standard cell may now be disconnected and any other source of emf. within the limits of the slide wire may be connected in place of the standard cell. The slider is moved to a point on the scale such that



FIGS. 1a AND 1b. SIMPLE POTENTIOMETER AND VOLTAGE MULTIPLIER.

there is no galvanometer deflection. The value of the applied voltage may now be read on the scale under the slider.

Should it be desired to measure a higher voltage, say 100 volts, a multiplier or volt box is used. The volt box is a high resistance with taps brought off at exact sub multiples of the total resistance. The particular box shown in Fig. 1 may have a resistance from 1 to 4 of 10,000 ohms, from 1 to 2 of 100 ohms, and from 1 to 3 of 1,000 ohms. With 100 volts from 1 to 4, there will be 1 volt from 1 to 2, or with 10 volts from 1 to 4, there will be 1 volt from 1 to 3. The voltage across the taps is measured on the potentiometer, the line voltage being a known multiple of the measured voltage.

When current is to be measured, as in checking an ammeter, the current is passed through an accurately adjusted low resistance, and the voltage drop across the resistance is measured on the potentiometer. A 0.1-ohm resistance will give one volt drop with 10 amperes passing through it.

In a commercial potentiometer the accuracy obtainable is many times greater than could be obtained with a slide wire and every detail is arranged for the greatest convenience and reliability. In the use of this instrument it is simply necessary to connect the different pieces of apparatus according to a diagram, which is supplied with the instrument, make a very few simple adjustments, and proceed with the required measurements. In some makes of potentiometers there is no slide wire, its place being taken by a number of resistance coils connected to dials. Other potentiometers have most of the resistance in form of coils, and a special form of slide wire in series with the coils. Almost all of these instruments have the connection to the standard cell tapped to the resistance in the potentiometer at the proper point, so that any manipulation of the dial switches is unnecessary when the potentiometer circuit is being adjusted by the standard cell. A diagram of a standard potentiometer showing this connection is given in Fig. 2.

When using the potentiometer it is necessary that precautions be taken to prevent any leakage currents or thermo currents in the circuits connected to the instruments. The galvanometer used with the potentiometer is very sensitive to small currents such as will leak through benches. The writer has found that at times it is impossible to use the potentiometer on 110 volts, with the instrument and galvanometer placed on a dry wooden bench. The same trouble has been encountered in a number of laboratories and trouble from leakage. In this laboratory the leakage currents different expedients have been adopted to overcome the were kept out by using well insulated wire for all circuits

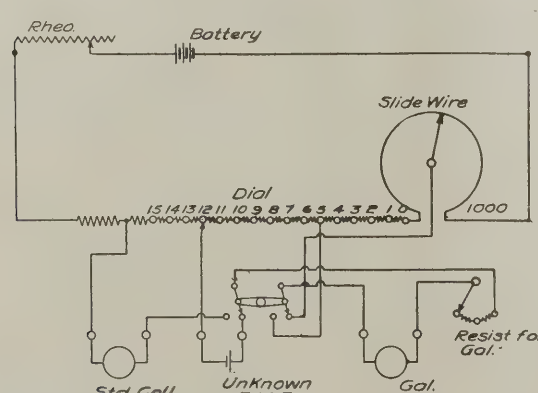


Fig. 2. A Standard Form of Potentiometer.

to the potentiometer bench and placing the potentiometer, standard cell and auxiliary battery on a large glass plate. which is supported by porcelain knobs. The galvanometer is on another glass plate and all wires connecting the potentiometer with its accessories are run through the air and clear of everything except the connecting posts.

Thermo currents and voltage may creep in in most unexpected ways. Trouble was experienced in using the potentiometer on one occasion, and it was finally found that it was caused by a lamp which was placed near the top of the galvanometer. The lamp heated the junction of the top suspension and its brass support. thus setting up a thermo voltage which was shown by erratic behavior of the galvanometer. Thermo currents may be set up by local heat in almost any part of the circuit. Hence, when using the standard resistances for current measurements, connections must be well made and a warm connection should be immediately made over. The presence of thermo voltage in a standard resistance or shunt may be determined by taking a reading with the resistance connected, then reversing the direction of the current through the resistance and reversing also the leads to the potentiometer. If there is any difference in the two potentiometer readings a thermo voltage is being produced in the resistance. For this test it is necessary to have some way of measuring the current to be sure that it is the same in the two checks.

RESISTANCE MEASUREMENTS WITH PORTABLE METERS.

Resistances, of alues between I ohm and 1,000,000 ohms, are measured most conveniently and accurately on a wheatstone bridge. For low resistance measurements in the laboratory, the potentiometer and a standard low desistance offer a most accurate method. When measuring the resistance of armatures, large transformer coils, etc., an ammeter may be put in series with the resistance and a millivoltmeter across the terminals. Another method, which is more accurate if absolutely steady current is obtainable, is to connect a low resistance standard, whose resistance is nearly the same as the resistance being measured, in series with the test resistance. Readings are taken alternately on the known resistance and the unknown resistance with a millivoltmeter. The values of the resistances are proportional to the millivoltmeter readings.

High resistances may be measured by connecting a voltmeter in series with the line and the resistance, taking a reading, and then taking a reading of line voltage. The unknown resistance is then $R = r\ (V \div V_1) - r$. Here R is the unknown resistance, r is the resistance of the voltmeter, V is the line voltage, and V_1 is the reading when in series with the resistance. This method is commonly used for measuring insulation resistance. The curve in Fig. 3 shows the variation of voltage with change in resistance for one voltmeter and one line voltage. For very high resistances a special high resistance voltmeter should be used and the line voltage should be 500 or over. Still higher resistances are measured by means of a high resistance box and a sensitive galvanometer.

TEMPERATURE DETERMINATION BY THE CHANGE IN RESISTANCE METHOD.

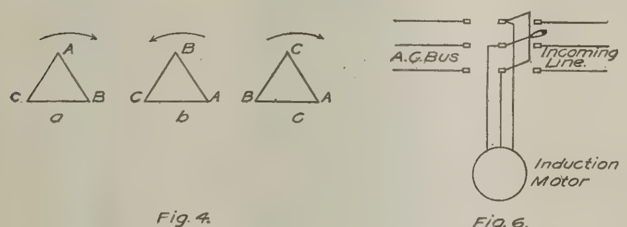
The actual coil temperature of a piece of apparatus is often most accurately measured by the change in resistance of the coil when it is heated. The formula given in the A. I. E. E. rules for the change of resistance of copper for change of temperature is $R_1 = R\ (1 + .0038t)$ from which $t = [(R_1 \div R)) - 1] \div .0038$. In these equations, t is the

Fig. 3. Insulation Resistance Per Volt Deflection. of Volt Meter. Voltmeter Resistance 18,000 Ohms, Test Voltage 100.

temperature rise in °C, R_1 is the resistance at the final temperature, R is the resistance at the initial temperature, and .0038 is the temperature co-efficient of copper at 25° C. For other initial temperatures the constant will not be .0038, but will be some other value, as .0042 at 0° C, and .00366 at 35° C. The value of this constant for temperatures from 0° C to 50° C is given in the "Standardization Rules."

NOTES ON "PHASING IN."

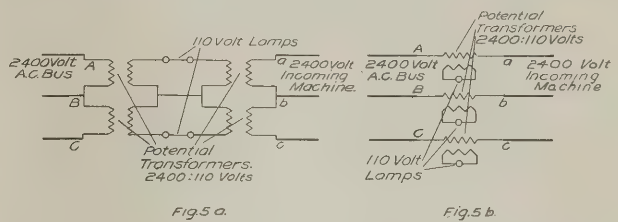
When two alternating current systems or generators are to be connected together it is necessary that the voltage of each be the same as the other, the frequency the same, and that the voltage waves of each system rise and fall together at the instant of connection. A further requirement is that the phase rotation of the two systems be in the same direction. All of these conditions except the last are shown on the station voltmeters and synchronizer. The phase rotation must be checked and made right when the apparatus is installed and need never be rechecked unless the main wiring is changed.



Figs. 4 and 6. Phasing in Diagrams.

If a new generator is started in a station and it is found that the phase rotation is wrong, it is necessary to change the places of any two leads in order to make the phase rotation right. Suppose the leads to the bus are as shown at (a) Fig. 4 and the phase rotation of the incoming generator is reversed as shown at (b). Reversing any two leads, for instance B and C, will make the sequence of phases the same for each machine. The diagram (c), shows the rotation correct, and the synchronizer and voltmeter will give all other necessary information for synchronizing.

The simplest method of proving the phase rotation is to tie the new machine to a machine with which it is desired to parallel, by closing all of the live switches before the machines are started. Both machines are now brought up to speed slowly and the field gradually raised. If the phases are reversed the machine ammeters will show a large current, and if the phases are right the current will be small. Another simple method is to start up an induction motor on first one system and then the other system, taking care that the leads on the motor are connected in the same order in each case, as shown in Fig. 6. The motor will run in the same direction on each if the phasing is right. Still another method, by the use of transformers and lamps may be used.



Figs. 5a and 5b. Diagrams for Phasing in With Lamps.

Connections are made as in Fig. 5a or b. If the phasing is right all the lamps will light up and go out together, but if the phasing is wrong, one set of the lamps will light up and as they darken the others will light up, showing that the voltages from A to a, B to b, and C to c are not the same at the same time.

Automobile Horsepower Determination.

A parliamentary committee recently appointed in England to consider amendments to the present method of determining the horsepower of automobiles for taxation purposes has reported and recommends few changes. The committee considered that the proper basis for rating should be the average power which the engine of a car could develop in regular use on the roads if there were no restrictions in speed other than those imposed by the car itself.

In gasoline and steam cars the present method of determining the horsepower is to divide the piston area in square inches by 2½ for engines of single-acting cylinders with a single piston; by 1 3-5 for single-acting cylinders having two pistons, and by 1¼ for double-acting cylinders having a single piston. It was recommended that this formula be left unchanged for gasoline cars. For steam cars, however, it was considered that the rating should be determined on the basis of the effective heating surface of the boiler rather than the dimensions of the engine, and that this heating surface should be taken to be the whole of the surface in the case of horizontal tubes and half the surface in the case of vertical tubes. The proposed rate is 1 horsepower for every 3 square feet.

For electric cars the present regulations prescribe that all motors shall be considered as developing 12 to 15 horsepower, and the committee recommends that this be lowered to 6½ to 12 horsepower. It is also recommended that motor cycles, which now pay a uniform tax of £1 each, be classified as motor cars, and that the following rates be imposed: Not exceeding 5-horsepower, £1 ($4.87); exceeding 5 but not exceeding 6½-horsepower, £2 2s. ($10.22); exceeding 6½ but not exceeding 12-horsepower, £3 3s. ($15.33).

Origin of Article in June Issue.

In the June issue of Southern Electrician on page 248 appeared an article entitled "The Cost of Generating Electrical Power in Small Plants." This article was presented in abstract and credit given to a writer of the Canadian Electrical News. The material originated in the engineering department of the American Engine Co., Bound Brook, N. J., and credit should have been given to that source.

Characteristics of Magnetite Arc Lamps.

(*Contributed Exlusively to* SOUTHERN ELECTRICIAN)

BY A. G. RAKESTRAW.

A Discussion of the Operation, Illumination and Application Features.

FOLLOWING the discussion of the ordinary flaming arc lamp in the August issue, a special form of the flamer will be taken up, known as the metallic flame arc, because the active material in the electrodes consists of metallic oxides. It is also called the magnetite lamp, on account of the fact that the principal oxide used is magnetite, the black oxide of iron. The distinguishing characteristic of this lamp is that the negative electrode consists of an iron tube filled with the oxides of iron, titanium and chromium. The presence of these oxides gives the arc the quality of "luminosity," and this lamp is therefore also called the luminous arc lamp. While the radiation is greatly increased it is not, however, noticeably selective, being a clear, brilliant white, free alike from the red and orange of the ordinary flamer, and the excess of the blue and violet found in the enclosed arc.

FIG. 1. TKE GENERAL ELECTRIC MAGNETITE ARC LAMP.

In construction, the magnetite lamp, while possessing some peculiarities, is similar in principle to the carbon arcs which have already been considered. There are two general types of the lamp, differing principally as regards the relative position of the electrodes, one having the iron tube above and the feed downwards, while in the other it is below and the feed upwards. In both of these cases there is no inner globe used.

In Fig. 1 the appearance of a luminous arc lamp having the negative electrode below is shown. The upper or positive electrode consists of a solid copper rod, enclosed in a thin iron tube, and has a life of from 2,000 to 4,000 hours. The tube containing the magnetite is ½ inch long and has a life of 120 to 150 hours, with 6.6 amperes of current. The reason given by the manufacturers of this lamp for having the electrodes in this relation is that it improves the distribution of the light, increasing the flux in the regions from 10° to 20° below the horizontal, which is particularly valuable for street lighting, and furthermore, as we will note later, there is formed in this arc, a bright spot of light close to the composition electrode. If this is placed above a means must be provided for keeping the arc from flaring upwards, as it obscures the light-giving part of the arc, exposing only the lower part, which is practically non-luminous. The feeding of the magnetite tube upwards avoids this. It is also claimed that there is less liability of the electrodes sticking when so placed.

In Fig. 2 the other type is shown, in which case the negative electrode is above. The lower or positive terminal of the arc consists of a small composition button, made of such a size as to just last as long as the tube of oxide, or about 150 hours. They are both replaced at every trim. Fig. 2 also shows the electrodes. The reasons given by the manufacturer for placing the electrodes in this position are as follows: A practically ideal distribution for street lighting purposes is secured. This may seem a flat contradiction to a similar statement made regarding the other arrangement, but if we refer to Fig. 5, which shows the

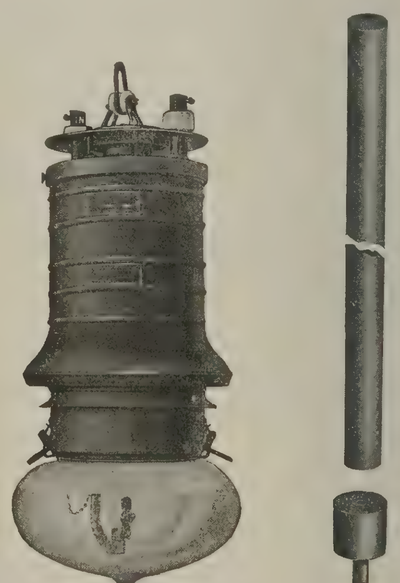
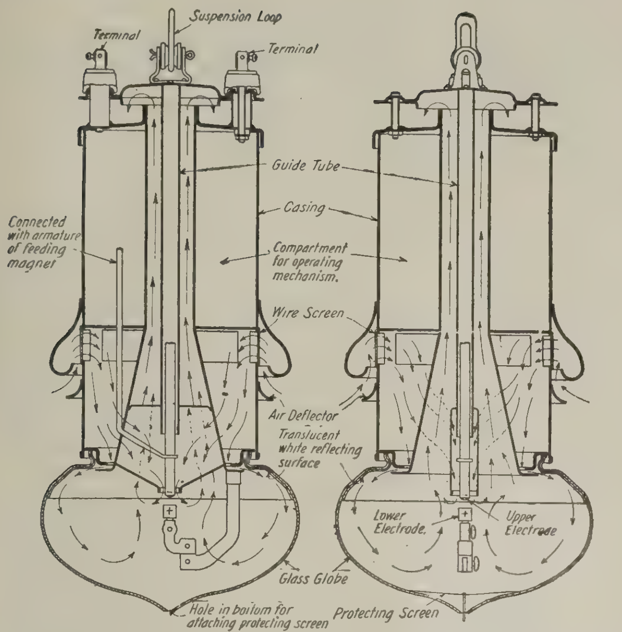


FIG. 2. THE WESTINGHOUSE MAGNETITE ARC LAMP AND ELECTRODES.

position of the electrodes and the luminous and non-luminous parts of the arc, and note the direction of the air currents in Figs. 3 and 4, creating a down draft around the arc, keeping it from flaring upwards and obscuring the light from this bright spot, we will see how this result is secured. Further reasons given are that a longer electrode can be used without unduly increasing the length of the lamp. Mechanism is simpler for a down feed than for an up feed, and a shallower outer globe can be used. Besides the function noted, the air currents carry off the products of combustion, which is very necessary. If the vapors from the arc are allowed to come into contact with any cool surface, they are deposited as a fluffy red soot, very troublesome to remove, and interefere with the successful operation of the lamp.

The principal application of the magnetite lamp is for



FIGS. 3 AND 4. SHOWING AIR CURRENTS IN WESTINGHOUSE LAMP.

street lighting, in which case they are put on D. C. series circuits, the direct current being usually obtained by rectifying alternating current. The luminous arc is now also used for mill work, and is made for multiple and power circuits. The magnetite arc is what is known as a shunt

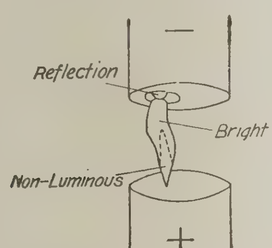


FIG. 5. SHOWING LUMINOUS AND NON-LUMINOUS PARTS OF THE ARC.

starting lamp, that is, the electrodes are normally not in contact, but are drawn together by shunt magnets upon the application of the current, and the arc established. Thereafter the length of the arc is regulated by the combined action of the shunt and series coils.

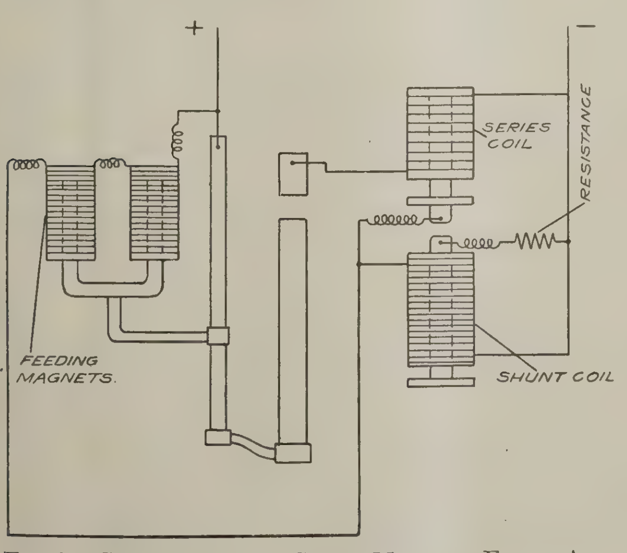


FIG. 6. CONNECTIONS FOR SERIES METALLIC FLAME ARC.

In Fig. 6 the connections are shown for the series lamp, and the performance is as follows: The electrodes being separated, current flows through the feeding magnets, which draw them together. As soon as current flows, the series magnets act, opening the carbon contacts and cutting

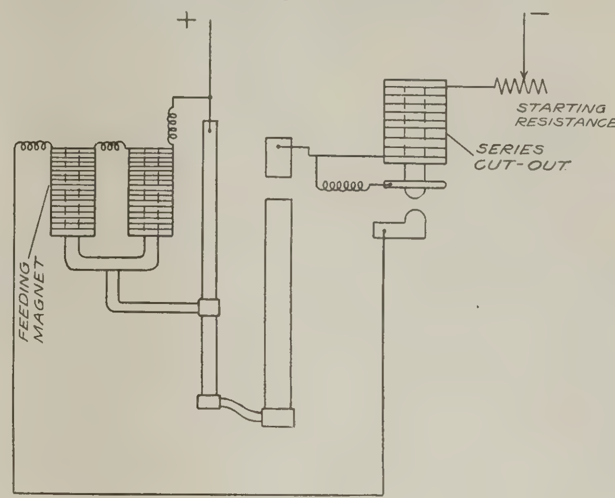
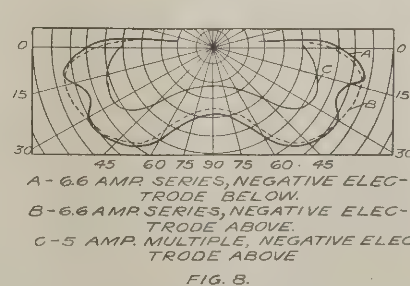


FIG. 7. CONNECTIONS FOR MULTIPLE LAMP.

the feeding magnets out. The arc is then struck and continues to burn with increasing length, until the voltage across the arc becomes sufficient to lift the shunt magnet armature, closing the circuit through the feeding magnets and restriking the arc. Fig. 7 shows the connections for the multiple lamp, which operates in quite a similar manner, except that the regulation is performed by the series magnet. On power circuits use is made of a differential feeding mechanism similar to that used for carbon arcs, with a series cut-out to insert substitutional resistance when required.

As to performance, we find that the magnetite lamp throws most of its light in a zone from 10° to 25° below the horizontal. When used for street lighting this tends towards an even distribution of light on the street, instead of a bright spot under the lamp and dense darkness elsewhere. Fig. 8 shows the distribution of 6.6 amp series lamps, with negative electrodes both above and below, also for a 5-ampere multiple lamp. Fig. 9 shows the distribution of the metallic flame arc as compared with several other types of arc lamps. Table No. 1 shows some figures as to light given and the current consumption. These are mean values, and are not taken from any particular make of lamp. The most striking proof of the value of this lamp for street lighting is given in Fig. 10, which shows the comparative distance at which a person can read print by the light of various street lamps. This is a real test of lighting



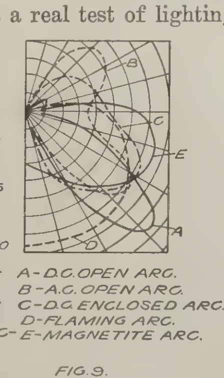


FIG. 8. DISTRIBUTION CURVE FOR MAGNETITE ARC LAMP.
FIG. 9. DISTRIBUTION FOR DIFFERENT TYPES OF ARC LAMPS.

value, showing much better than any figures of light flux could do, that the lamp really puts the light where it is needed.

TABLE I—PERFORMANCE OF MAGNETITE LAMPS.

Connections	Amp.	Volt Ext.	Volt Arc	Watts	Mean s ph c p	Mean hemis-pherical c p	Watts per m s c p	Watts per m. h. s. c. p.
Series	4.0	78	75	310	255	474	1.21	.66
"	6.6	78	75	510	654	1122	.78	.45
Multiple	4.0	110	75	440	225	491	1.96	.9
"	5.0	110	75	550	364	710	1.5	.78
" ...	6.5	110	75	715	720	1395	.99	.51

Note:—These are average figures taken from different observations and types of lamp.

Since the metallic flame arc is a constant current D. C. lamp, it could, of course, be used on a D. C. arc machine such as the Brush or T-H, but since it is adjusted for 4 or 6.6 amperes while these machines are all wound for 9.8 amperes, it would necessitate rewinding the generator for efficient operation. While this is sometimes done, yet the fact that high tension A.C. is now being used almost exclusively for distribution, makes it desirable to use an A.C. source of supply, which is converted to D.C. by means of a mercury arc rectifier.

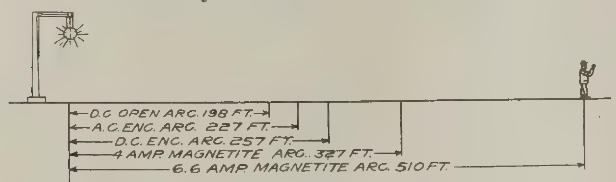


Fig. 10. Comparative Distances at Which a Printed Page Can Be Read.

In this system we have first a constant current transformer connected to the A.C. supply. In this transformer the primary and secondary coils are movable, being balanced by counter weights. As the load changes the varying induction causes these to move in such a manner as to keep the current practically constant. These transformers will give a constant current from full to one-third load. This constant current is then rectified by means of the mercury arc rectifier, the connections of which are shown in Fig. 11. This reverses one-half of every cycle, as shown in Fig. 12, by the heavy dull line, giving an unidirected but pulsating current. To reduce the pulsations, a reactance is inserted in the D. C. side of the circuit, giving a curve for the current something like the dotted line. Fig. 13 shows connections for the entire system using one rectifier tube and a 50-light outfit. A small exciting transformer is used in starting, and by shaking the tube slightly a small arc is started between the auxiliary electrodes. The main switch is then closed and the main arc established.

Fig. 12. A Rectified or Modified Alternating Current.

The efficiency of this system at full load is given as from 85 per cent to 90 per cent and the power factor is from 65 per cent to 70 per cent. One advantage lies in the fact that luminous arc lamps, flaming arcs and series tungsten lamps may all be used on the same circuit without any change whatever, thus taking care of business sections and residence districts on the same circuits.

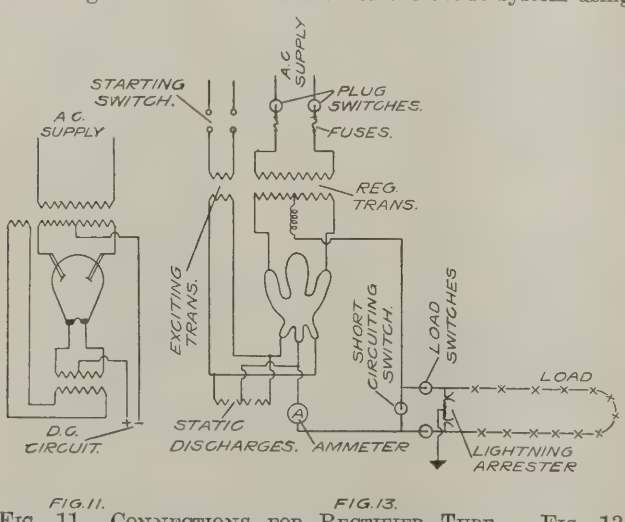


Fig. 11. Connections for Rectifier Tube. Fig. 13. Simplified Connections for Arc Lighting System.

The Society for Electrical Development Organized.

One of the most interesting and vital meetings of electrical interests, including central stations, manufacturers, jobbers, contractors and dealers, was the one held at Association Island, Lake Ontario, in the early part of September. More than 100 of the most influential men in these branches of the industry came to this meeting for the purpose of devising ways and means for closer relationship among all interested in the sale, installation and distribution of electrical apparatus or electric service.

The remarkable features of this meeting are best indicated by the results and actions taken. Practically every one favored the spirit of the movement and steps were immediately taken to create an organization of such a nature as to extend the work of co-operation throughout the country. The following were chosen to serve as a committee on organization:

For the Central Stations—Henry L. Doherty, H. L. Doherty & Co., New York City, chairman; J. E. Montague, Buffalo & Niagara Falls Electric Light and Power Co., Niagara Falls; Walter H. Johnson, Philadelphia; A. C. Einstein, Union Electric Light and Power Co., St. Louis; John F. Gilchrist, Commonwealth Edison Co., Chicago.

For the Electrical Jobbers—W. E. Robertson, Robertson-Cataract Co., Buffalo, chairman; W. W. Low, Electric Appliance Co., Chicago; Roger V. Scudder, Wesco Supply Co., St. Louis; F. S. Price, Pettingell-Andrews Co., Boston; Gerard Swope, Western Electric Co., New York City.

For the Electrical Contractors—Ernest Freeman, Chicago, chairman; Ernest McCleary, Detroit; Philip N. Thorpe, Paterson, N. J.; James R. Strong, New York City; G. M. Sanborn, Indianapolis.

For the Electrical Manufacturers—A. W. Buchard, New York City, chairman; L. A. Osborne, Pittsburgh; W. A. Layman, St. Louis; J. Robert Crouse, Cleveland; B. M. Downs, Covington, Ky.

Philip S. Dodd, of New York City, secretary.

The forming of this new society really means the getting together of the four branches of closely associated business, central stations, contractors, jobbers and manufacturers, in an endeavor to develope co-operatively the business as a whole, so that each interest will be benefited. The plans will include a central bureau for the carrying on of the work, which will be along the lines of advertising and publicity for the education of the public to the greater uses of electricity for light, heat and power.

Conditions, Practice and Developments in English Central Stations

Contributed Exclusively to Southern Electrician.
BY CECIL TOONE, AN ENG LISH CONSULTING ENGINEER.

Section 4a. Gas and Oil Engine Stations.

IN this section the writer will take up the utilization of gas and oil engines, water wheels and turbines in English central stations, dealing briefly with the early prospects of these prime movers, at greater length with the present condition of their development and use, and, briefly again, with future prospects. Improvements in the design and manufacture of suction gas plants have led to an increased utilization of this equipment in central stations (though the latter represent but a very small fraction of the total application). At the present date the percentage of English central stations driven by suction gas plant is low (see Table 3, Southern Electrician, Vol. 43, page 186; also later paragraphs), but there is every prospect of a wide adoption of this class of plant in small towns at present lacking electric supply.

In stations of less than 500 kws. capacity, to which the suction gas plant is mainly confined at present, the capital cost of steam driven equipment (including buildings and all accessories), is at least 20 to 30 per cent higher than the cost of equivalent suction gas plant. Moreover, the latter is specially suited to the limited hours service still maintained by many small stations. Many small stations still shut down at 11 or 12 p. m., leaving the battery (if any) to carry the night load. Twenty-four-hour service is, however, becoming more and more common. Heating and cooking loads are beginning to exercise a most beneficial effect on the day load factor of our central stations, but ice-making and steam-heating loads, which are so useful to many of your stations, are non-existent here. In this respect oil engines are yet superior. Any good make of oil engine will run for hours without the slightest supervision, whereas it is unsafe ever to leave producer gas plant entirely unattended.

The Diesel engine has been greatly improved during recent years and now enjoys considerable application in central station service, but there is, at present, much the same diversity of opinion regarding the merits of these and other oil engines as at one time raged over producer gas plants.

As to the fuel economy of Diesel engines, there can be no doubt but there is much incertitude as to the maintenance and repair costs of oil and gas engines as compared with one another and with steam engines. There is a widespread opinion that all internal combustion engines will show a greater increase in repair costs than steam engines after a few years in service. In the case of producer plant, this objection is largely offset by the low maintenance costs of a "producer" as compared with those of a steam boiler of equivalent output. A detailed treatment of the capital and operating charges on various types of power plants is to be given in Section 10 of this series on "Capital and Running Costs."

TYPES OF GAS PLANT.

Very few English central stations employ gas engines running on town gas, owing to the high cost of the latter as a power and fuel and owing to its high clorific value, which introduces well-known technical difficulties into the design and operation of large units. The suction gas plant is by far the most commonly employed type. The lower capital cost and simpler working, as compared with pressure gas equipment, compensates for the better grade of fuel required. The writer's observations in a number of gas driven stations show the difficulty of working suction plant on light loads to be much less than is often stated. Coke oven and blast furnace gas is used to a very large total extent in various large private central station in colliery areas. Concerning these cases, information will be given in an independent article at a later date.

EXISTING GAS AND OIL DRIVEN STATIONS.

The following particulars refer to stations driven exclusively by gas or oil engines, as the case may be. The important group of stations driven by a mixed equipment, partly consisting of gas or oil engines or water turbines is treated in a separate sub-section below. Referring to Table No. 1, the predominance of the smaller stations and the later date of opening of the latter will be obvious. As time goes on, most of the small stations will move into a higher kilowatt group so that the mean year of commencement of supply in the various groups will steadily advance. It is interesting to note that company enterprise is considerably ahead of municipal (or local authority) enterprise in establishing small undertakings. Direct current supply is almost exclusively afforded by the latter, and, in all but the smallest concerns, 3-wire distribution (usually at 400, 440 and 200, 220 volts) is adopted. Bare overhead distribution lines are steadily gaining favor in small undertakings.

It may be noted that the maximum load on the various "all-gas" stations dealt with in Table 1, ranges from ⅓ to ¼ of the connected load which in turn, varies from 1.5 to 3.0 times the generator capacity of the stations. The number of consumers supplied per kw. of generator capacity varies from 2, in the smaller, to 1 in the larger stations of this group. The average capacity per generating set is only 26 kws., in the 17 gas stations treated in the 0/100 kw. group. Where two or three sets are employed their capacity rises in the following approximate ratios: 1/1 or ½; 1 / 1 / 1.25-2.0. The average lighting and power tariffs shown here and later should be compared with the corresponding averages for the whole country as given in Southern Electrician March, 1911.

In the 0/100 kw. stations Crossley-Crompton generating sets are predominant, but in the larger stations a very heterogeneous electrical equipment is driven by Crossley, Campbell, Stockport and Westinghouse engines in practically equal numbers. Suction gas producers and anthracite fuel are almost exclusively used. Three stations oper-

ate on town gas and eight employ Dowson pressure producers. Three purely oil driven station (all in the 100/250 kw. group) employ Diesel engines, the average size of unit being 71 kws. The total generator capacities of the three stations are 200, 200 and 240 kws., but the numbers of units employed are 2, 3 and 4, respectively.

At Worthing, two 125 kw. Diesel driven extension units are installed at a total cost of $22,000 and, in Bath, an 800 i.h.p. Diesel engine driving a 450 kw. dynamo is installed, at a cost of $27,500 for engine and generator, and $37,500 for the complete equipment. A net annual saving, after deducting interest charges, of $7,800 is expected, and, during the summer months, the Diesel set will take over the whole load, enabling the station staff to be reduced from six to one.

from the storage cells is a thoroughly good method, but is complex in application. The most generally adopted system at the present day is to start up on compressed air, stored in steel drums at 150 to 200 pounds per square inch, by engine, or electric motor driven compressors. An ample reserve of air is necessary to cover leakage and the possibility of unsuccessful starts. To save the cost of a compressor the engine may be allowed to exhaust into the storage drum till the desired pressure is attained in the latter.

Whatever ignition system be employed it is usual to duplicate the firing device in each cylinder. Flame ignition is obsolete, but tube ignition is still employed to a limited extent. Firing tubes cost from 3 to 6 cents each and seldom last more than one day. Apart from the cost of their

TABLE 1. DATA ON PRIME MOVERS IN ENGLISH STATIONS.

KW. RANGE	0—100			100—250				250—500		500—1000		1000—2500	TOTALS			
Prime Movers	G	W	M	G	O	W	M	G	M	G	M	M	G	O	W	M
No. of Stations	17	3	8	15	3	2	10	9	8	1	12	2	42	3	5	40
Mean Yr. Commencement of Supply	1906	1904	1900	1904	1899	1893	1898	1900	1897	1900	1900	'01/'02	—	—	—	—
Company Owners	10	3	8	10	2	2	7	4	5	1	5	1	25	2	5	26
Local Owners	7	—	—	5	1	—	3	5	3	—	7	1	17	1	—	14
D. C. Supply	17	3	8	14	1	—	7	7	5	1	7	1	39	1	3	28
A. C. Supply	—	—	—	1	—	2	3	—	2	—	1	—	1	—	2	6
D. C. & A. C. Supply	—	—	—	—	2	—	—	2	1	—	4	1	2	2	—	6
2-Wire D. C.	10	2	2	1	1	—	2	2	2	—	1	—	13	1	2	7
3-Wire D. C.	7	—	6	13	2	—	5	7	4	1	10	2	28	2	—	27
Total Connected Load	2100	64	1400	3240	562	280	3170	5200	4700	1570	12510	4293	12110	562	344	26073
Average Ditto per Station	122	21	175	216	187	140	320	580	587	1570	1042	2146	—	—	—	—
Total Maximum Load.	660	26	350	1150	248	128	1050	1670	1543	450	4443	3160	3930	248	154	10546
Average Ditto per Station	39	9	45	76	83	64	105	185	193	450	370	1580	—	—	—	—
Average Consumers	110	34	120	150	192	170	186	280	421	500	600	876	6554	575	436	14583
Average No. Generating Sets	2.2	1.6	2.6	2.4	3.0	2.0	3.2	3.1	4.1	3.0	5.0	10.5	—	—	—	—
Total Gen. Capac.	950	98	575	2110	640	275	1710	2825	2980	585	7850	3800	6470	640	373	16915
Mean Gen. Capac. per Station	58	33	72	140	213	137	171	314	375	585	654	1900	—	—	—	—
Mean Kw. per Set	26	20	28	59	71	68	53	100	91	195	131	181	—	—	—	—
Per Kw.hr.—Light cts.	10.6	10.6	12.0	10.4	13.2	11.0	11.5	10.2	10.9	12.0	9.8	8.5	—	—	—	—
—Power cts.	5.0	4.5	5.4	4.2	6.5	5.0	4.7	4.2	5.4	5.0	4.0	4.0	—	—	—	—
Gas, per M. cu. ft. $	1.00	1.20	1.00	0.80	1.00	1.20	1.00	0.78	0.88	0.88	0.82	0.74	—	—	—	—
Gas Owners—Co.	10	1	6	7	3	—	8	5	5	1	10	2	23	3	1	31
—Local	2	—	—	6	—	1	1	4	2	—	2	—	12	—	1	5

G = Gas-driven stations; O = Oil-driven stations; W = Water-driven stations; M = Mixed prime mover equipment.

TECHNICAL NOTES ON GAS AND OIL PLANTS.

The single acting 4-cycle gas engine is still standard in this country and there is considerable dissension as to the advantages of the double acting type. Probably the latter will be widely adopted, particularly in large units, in the immediate future. Vertical engines enable better balancing, steadier running and facilitate the employment of a number of cylinders, thus securing short stroke and high r.p.m for a given speed, besides occupying less floor space than the equivalent horizontal engines.

Great improvements have lately been made in the design of producers, resulting in reduced maintenance costs and more efficient working. A periodical thorough cleaning of the plant reduces running and maintenance costs very considerably and all purifiers, etc., should be so arranged as to be capable of sectional inspection and cleaning without involving complete shutdown of the equipment. The gas holders in Dowson plants erected in the past have often been of insufficient capacity.

Manual starting of gas or oil engines is impracticable except in the smallest units. Rather crude methods of starting by power are to pump one explosive charge into the cylinder and then fire or start up on petrol, both methods subject the engine to sudden severe strains. A better method, but one which finds little application, owing to the complication involved, is to start up by steam drawn from a pressure producer boiler or other auxiliary boiler. Starting the engine by running the dynamo as a motor

renewal, the risk of preignition is a serious objection. Electric ignition with duplicate sparking plugs on each cylinder is by far the best system available. Low tension ignition from a 10-volt battery may be employed permanently or merely during starting. Low or high tension magneto ignition is generally used, and in several stations miniature motor generators are installed to supply ignition current. The latest National gas engines are, in the larger sizes, provided with low and high tension Bosch magneto ignition and battery ignition (selection by three-way switch). For poor mixtures high tension ignition is recommended as having a slight advantage.

"Hit-and-miss" governing is steadily going out of favor. The system is economical of gas, but permits more or less serious "hunting" at all loads less than full. "Throttle" or "quantity" governing gives best results on engines driving electrical machinery. Governing by "quality" is satisfactory except on very light loads. In some cases, quantity or quality governing is employed down to about 1/3 full load, "hit-and-miss" governing being then employed for lower outputs. An overload capacity of 25 to 30 per cent for short periods and 15 to 20 per cent for two hours or longer is frequently specified. The mechanical efficiency of gas and oil engines is appreciably lower than that of steam engines, owing to the heavier moving parts necessitated in the former by the high explosion pressures and owing to the great amount of idle movement in the Otto cycle. Double-acting engines avoid the latter source of inefficiency, but

involve a certain (though lower) frictional loss in their auxiliary cylinders.

In thermal efficiency, however, all internal combustion engines are inevitably superior to the most efficient steam engines or turbines. Further information in this direction has already been promised in connection with the later treatment of Capital and Running Costs.

Inland towns often find considerable difficulty in disposing of the effluent from pressure producer plant. The "washer" water pollutes streams to an objectionable extent and cannot conveniently be discharged into sewers unless previously cooled. Treatment with lime precipitates the sulphur compounds as sludge. The injection of water spray into the exhaust pipe cools the gases and silences their expulsion, but the sulphuric oxides in the gases combine with the water to form a certain amount of sulphuric acid which quickly destroys the piping. "Exhaust boilers," say of the Wilson type, form an excellent means of silencing the exhaust in large installations. The most usual means of silencing are to convey the gases to a pit filled with coke, or provided with stoneware pipes to break up the gases, or to use steel drums filled with shingle or fitted with perforated baffle plates. At Stratford there is employed a novel means of raising steam for the suction producers in use. Water is allowed to trickle over a length of the hot exhaust pipe located in a brick chamber, whence the producer sucks steam as required. This arrangement cools the exhaust and greatly simplifies and improves the working of the producers.

If but a single gas producer is installed or if the capacity of the plant is insufficient to cover the possibility of one producer breaking down, town gas should be provided as a standby fuel wherever possible. It speaks well, however, for the reliability of the suction gas plant that a number of stations employing the latter and provided with a gas reserve, have never had occasion to use it.

Developments in the design of high speed gas and oil engines have dispensed with the use, in modern equipments, of the leather or cotton belt or rope drives which formed so salient a feature in early gas-driven stations. Section 46 will treat water and turbien stations.

An Analysis of the Losses of a Hydro-Electric System.

BY J. D. ROSS, MEMBER A. I. E. E.

LITTLE actual data is now available showing losses at the various points in existing hydro-electric generating and distributing systems. After preparing calculations for use in a prospectus in the course of financing the system, the desire to know operating details does not, in the average case, seem sufficient to warrant the necessary tests to determine how closely the actual operating conditions in each and every part of the system check with the calculated or assumed conditions and the results of factory tests. In every case where this is true, it is safe to guess that conditions exist which, if only corrected in part, would effect not only improved operating conditions, but a decided saving through getting more out of the same or as much from a less capacity. This applies especially to engineering work so young as that encountered in some of our large high tension systems. No engineer is infallible, and it is no reflection on the best of them to show a strong desire to know the details of operating and the actual conditions even some time after the system has been turned over and out of their control That a general indifference is fostered both by owners and engineers does not aid engineering progress in a field where millions of dollars are annually invested and usually on the opinion of a capable engineer. The small cost that would be entailed to secure this data generally and place it at the disposal of engineers would prove a most valuable asset to the prospective investor and place the engineer in a position that he may be assured of equal, if not improved results through each successive plant with which he is connected. The more practical data available, the better the engineering, the greater the assurance of a better return on the capital invested and an ability to provide customers with the best possible service.

A paper was recently presented before the American Institute of Electrical Engineers by Mr. J. D. Ross, in which he discusses the vital points of plant efficiency and the results of tests on the hydro-electric plant and lines of the Seattle Municipal Light and Power system. In the discussion on this paper, while there was some objection to the author considering the station and substation lighting as losses to the system, the general treatment was complimented by a number of prominent engineers, as valuable material on the subject of plant efficiency. The carefully and accurately computed results given by the author gives the data this general interest and value and we present the material in what follows:

Fig. 1. Loss of Head in Feet in Various Parts of 67.75-Inch Wood Stave Pipe.

Velocity in ft. per second	Loss in entry and screens	Elbow No. 1 92°	Elbow No. 2 55°	Elbow No. 3 60°	Elbow No. 4 65°	Elbow No. 5 45°	Total loss in pipe	Friction loss after deducting entry and elbows	Loss in 67¾" stave pipe per 1,000 feet	Value of C. in Kutters formula	Value of N. in Kutters formula
2½	.06	.03	.03	.03	.03	.01	4 1	3.91	.246	134.06	.01190
5	.25	.09	.08	.08	.08	.05	15.4	14.77	.931	137.96	.01175
7½	54	.25	18	.19	20	14	33.9	32.40	2.0425	139.71	.01165
10	1 14	.46	.34	.36	.37	27	61.9	58.96	3.775	137.01	.011865

Note: 1 ft. =0.3048 in.

THE SEATTLE PLANT—PIPE LINES AND PENSTOCKS.

The Seattle plant is a hydroelectric system delivering water to two 1,500 kw. Pelton units and two 5,000 kw. turbine units under 600 ft. head, through two pipes approximately 3½ miles long, one of which is 67¾ and the other 49 in. inside diameter. The current is transmitted at 60,000 volts through two lines to Seattle, a distance of 38.7 miles, and is there distributed at 15,000 and 2,400 volts for use by approximately 20,000 customers and for the city street lighting. The 67¾-inch pipe consists of 15,865 ft. of wood stave pipe dividing at a point 951 ft. from the power house int)

two48-in. riveted steel penstocks. The 49-in. wood pipe joins onto a 48-in. riveted steel penstock at a point 1,008 ft. from the power house.

Careful tests were made on the 67¾-inch wood stave pipe, using gauges calibrated before and after. The pipe contains five steel elbows, where the curvature is greater than 20 degrees. These elbows are made to a 15-ft. radius and have angles respectively 92, 55, 60, 65 and 45 degrees. The loss in head of each elbow was measured by a differential pressure gauge. The results of the test are given in detail in the following table:

The loss in entry, as given in the above table, seems large and rises with the velocity more rapidly than it should. This, it is said, is due to the resistance of the screens, which are of wood bars. The entry of the pipe is bell-mouthed and the total length of the wood pipe is 15,865 feet. The line was designed for a slope of four feet per thousand feet to give a velocity of ten feet per second. The loss in the penstocks was computed from records taken by Bristol recording gauges at the generating station, which were frequently calibrated. The results so obtained were checked by computing the loss from the efficiency shown under test, and agreed very closely. The maximum output of the two penstocks was 12,400 kw., with a loss of 6 per cent, and the average output for the year was 6,009 kw., with an average loss of 2.3 per cent. This loss was increased by the fact that the plant was supplied for thirty-three days in November and December by the larger pipe alone.

GENERATING STATION EQUIPMENT.

There are four units in the power house, two of which consist of 8,000 h.p. Francis turbines direct-connected to 60-cycle, 2,300-volt, three-phase generators rated at 4,000 kw. at 35 deg. C. rise, with four hour overload capacity of 5,000 kw. at 40 deg. C. rise. These units operate at 600 r.p.m. The other two units are driven by 2,400 h.p. Pelton impulse wheels direct-connected to 60-cycle, 2,300-volt, three-phase generators rated at 1,200 kw. at 35 deg. C. rise, with four hour overload capacity of 1,500 kw. at 40 deg. C. rise. These units operate at 400 r.p.m. The wheels are each equipped with two runners, each of which is supplied from a needle and a deflecting nozzle. The combined capacity of the present installation is therefore 13,000 kw. on a 40 deg. C. rating. The two machines last mentioned, however, exceed their rating and have been operated continuously without excessive heating at 1,750 kw., making the combined capacity 13,500 kw. Three water wheel exciter units are installed, two of which have a capacity of 75 kw. each, and the third 150 kw.

As the efficiency of each unit varies with the load, and it is obviously impossible to have all generators that are in use at any time carry their full load, the all-day efficiency of the generating station will depend on the number of units in use and the load which each carries, as well as on the power factor of the load and, in the case of this plant, where two types of wheels are used, it will also depend on the proportion of the load that the operator gives to each type of machine. While the combined maximum efficiency of generator and wheels was found in the case of the 5,000 kw. units to be 76.7 per cent, and in the case of the 1,500-kw. units to be 69.9 per cent, the all-day efficiency of the plant for 1911 was found to be 56.7 per cent. This does not include current for excitation and station lighting. By including this as a loss, the all-day efficiency of the plant drops to 55.7 per cent. The reason for the difference in the same type of unit is found in the fact that the operators favor No. 1 and No. 4 machines, from habit rather than intention. The impulse wheels, being small, are operated under full load for a great part of the day and their all-day efficiency is greater than that of the turbines, notwithstanding the higher efficiency of the turbine sets at full load. It will be readily seen from these facts that the efficiency of a plant depends very largely on the way it is handled by the operator, and during low water periods it is possible to prepare a schedule showing which machines should be used for each load which the plant carries. This schedule will be modified by the conditions of the plant, changes in load and regulation.

Losses in the water wheels and generators were computed from the half-hour wattmeter readings on the generators as recorded in the station report. The input for each output throughout the year was computed from efficiencies shown in tests made in 1909 and checked at the end of 1911. The results show all-day efficiencies for the year as follows:

EFFICIENCY.

	Wheel	Generator	Combined.
Impulse Unit No. 1.........	70.8	93.0	65.8
Impulse Unit No. 2.........	66.3	92.2	61.1
Turbine Unit No. 3.........	57.1	93.0	53.1
Turbine Unit No. 4.........	63.6	94.1	59.8
Four units combined.........	60.7	93.5	56.7

The higher efficiency of the impulse units is due to the fact that they were nearly always loaded above 900 kw. and the regulating was done with the relief valves and governors on the turbines, so that there was little loss from the deflecting nozzles. The power used in excitation was computed from the half-hour readings on the exciter outputs, and amounted to 399,120 kw.h. or 1.3 per cent of the output of the generators. The water input to the exciter units, computed similarly to that of the large units, was 665,200 kw.h. Station lighting, including light for the employees' cottages, amounted to 175,000 kw.h. for the year.

STEP-UP TRANSFORMERS.

The station is equipped with nine transformers. Each bank of three has a normal capacity of 4,500 kw. at 35 deg. C. temperature rise. These transformers step the voltage from 2,300 to 60,000 volts three-phase star connected. The neutral of the star connection is grounded. These transformers were all in circuit continuously to keep them in good condition, and their core losses were practically constant, amounting to 926,000 kw.h., or an average of 11.7 kw. per transformer. The copper loss was computed from the readings on the reports, and amounted to 200,000 kw.h., or an average of 2.54 kw. per transformer.

	Kw.h.	Average kw.
Core loss..................	926,000	106
Copper loss...............	200,000	23
Total loss..................	1,126,000	129
All-day efficiency.................	96.1 per cent.	

HIGH-TENSION LINES.

There are two high-tension lines 38.7 miles in length strung on two different makes of insulators of practically the same size and type. One of these lines is of No. 2 solid medium hand-drawn copper, the wires being placed in a six-foot triangle. The other is built of No. 0000 seven-strand hard-drawn copper, the wires being in a seven-foot triangle. The line loss was computed from the constants of the lines, taking the load data shown by the report sheets. The line resistances were measured by direct current, using the fall of potential method, and agreed very closely with

the computed value. The inductance and capacity were calculated from the values given in the Standard Handbook, third edition. To simplify calculation for the all-day efficiency, a Perrine-Baum regulation diagram was drawn for both lines in parallel. To this were added circles, taking as a center the end of the substation voltage, and as a radius the square of the voltage drop in the line, multiplied by the conductance of the line. The radii of these circles represent power loss. The power loss during 1911 on the two lines, figured from this diagram, using the half-hour readings at the substation for load data, amounted to 378,000 kw.h., or an average of 43 kw. for the year.

	Kw.h.	Average kw.
Line loss	378,000	43
All-day efficiency	98.6 per cent.	

STEP-DOWN TRANSFORMERS.

The step-down transformers are placed on the first floor of the substation. There are at present eight of these, each of 1,500 kw. capacity at 35 deg. C. temperature rise. All are made with a ratio of 54,000 volts, three-phase to 15,000 and 2,500 Scott connected two-phase, making four banks of transformers. The low-tension coils are connected in series for 15,000 and in multiple for 1,500 volts, two banks being used on each voltage.

The step-down transformer loss, computed in the same way as that of the step-up transformers, was as follows:

	Kw.h.	Average kw.
Core loss	692,000	79
Copper loss	217,500	25
Total loss	909,500	104
All-day efficiency	96.6 per cent.	

The sum of the losses in line and transformers was checked against the difference in the watt-hour meter readings on the low-tension side of the transformers at each end of the line, and was about five per cent lower. This may not have been due to error, but may be largely due to corona loss or other line leakage. No measurements have as yet been made to determine this point.

MAIN SUBSTATION.

The main substation contains the step-down transformers, a distributing switchboard of the remote control type, and the necessary switching and control apparatus for the distributing feeders. The switchboard carries a complete set of curve-tracing meters for the high-tension lines, indicating ammeters and wattmeters and watt-hour meters for the transformers, and indicating ammeters, recording voltmeters and watt-hour meters for the feeders. Loss in meters and their instrument transformers was computed from tests made on each type of meter and transformer. Current used for station light, heat and display lighting was metered.

	Kw.h.	Average kw.
Loss in meters	29,000	3
Power for station light	317,400	37
Total loss	346,400	40
All-day efficiency	98.7 per cent.	

MOTOR-GENERATOR SET.

A motor-generator set consisting of a 750-hp., two-phase synchronous motor direct-connected to two 250-kw. 250-volt d.c. compound-wound generators is used on a three-wire 500 and 250-volt system for operating elevators and other motors. The maximum load on this machine at the present time on the direct-current side is 300 kw. and the average load for 1911 was 30.2 kw. The surplus kilovolt-ampere capacity of the motor is utilized in regulating the voltage of the main system by varying the power factor by means of a Tirrill regulator controlling the field of the motor. There are at present 71 services connected on this system with a connected load of 772½-hp. The main feeder is 750,000 c.m. cable with a 400,000 c.m. neutral, and the branches usually No. 4/0 with No. 2/0 neutral. In all, 27 miles of wire are used on this system.

The total loss in the direct current feeders and the motor-generator was obtained from the difference in the motor watt-hour meters and the customers' meters. From recording volt-meter charts taken at various distributing points and at the substation and from computations, using the load data and line resistance, the line loss is placed at 5 per cent. The details of losses and efficiences follow:

	Efficiency, 1911	Loss, kw.hr.	Average loss. kw.
Motor-generator	38.	417,000	48
Direct-current lines	95.0	12,800	1
Customers' meters	98.8	3,000	..
Total direct-current system	35.7	432,800	49

15,000-VOLT SYSTEM.

Current is distributed at 15,000 volts from the main substations to two smaller substations and to about twelve mills and factories which use large amounts of power. This system is two-phase, with the center point of each phase grounded. For mechanical reasons, No. 2 is the smallest wire used on the 15,000-vole lines. There are about 105 miles No. 2, nine miles of No. 1 and two and one-half miles of No. 0 wire. There are 30 transformers connected, ranging in size from 750 kw. to 50 kw., with a combined capacity of 6,250 kw.

Loss in the 1,500-volt system was found by taking the difference in the meter readings at substation and at the various receivers, and checked closely by calculation from

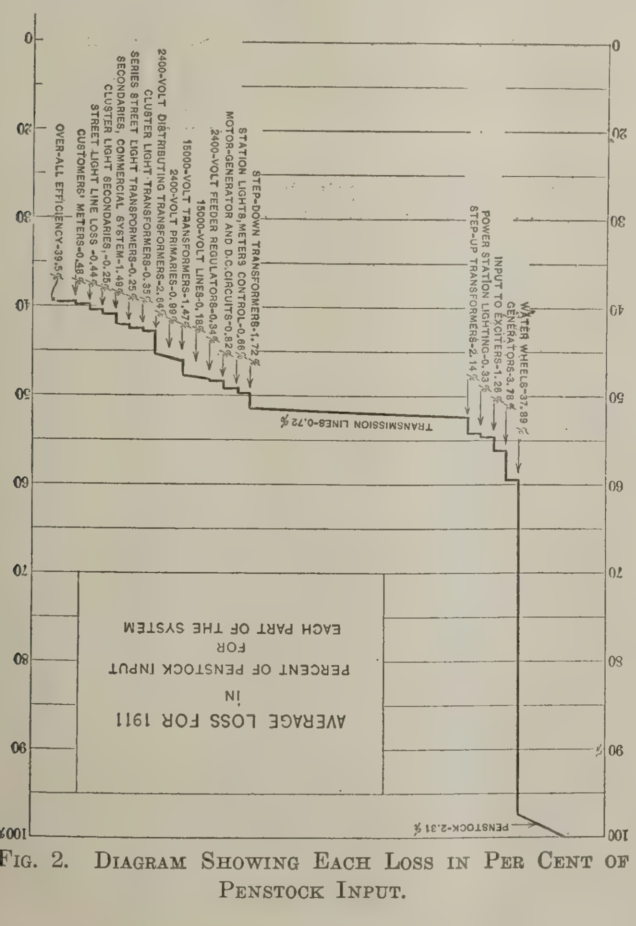


FIG. 2. DIAGRAM SHOWING EACH LOSS IN PER CENT OF PENSTOCK INPUT.

the line constants and load data. The transformer losses on this system were computed from the load data on the station reports and the tests taken on each size and type of transformer under actual operating conditions. Copper loss is small compared to core loss because the transformers were lightly loaded; an installation of 6,250 kw., carried an average of 1,323 kw. The detail losses were:

	Efficiency, 1911	Loss kw-hr.	Average loss. kw.
15,000-volt lines	99.2	93,500	11
15,000-volt transforfers	93.2	775,100	88
Core loss		694,000	79
Copper loss		81,100	9
Total for system	92.5	868,000	99

2,400-VOLT DISTRIBUTING SYSTEM.

Power is distributed from the substations by means of seventeen 2,400-volt primary feeders. The more heavily loaded circuits were designed for 200 amperes and the lighter ones for 150 amperes. Number 4/0 wire was used at first, but the economic size for a 200-ampere feeder has been computed at 350,000 c.m., which size is now used on the heavier feeders. An area of 28 square miles is served by this system, a distributing point being established at the approximate center of distribution for each feeder, and the automatic regulators in this station are set to give the desired voltage at this point. Connected to the 2,400-volt feeders are 1,082 distributing transformers, ranging in size from 2½ kw. to 50 kw., and with an aggregate full-load capacity of 9,268½ kw. They are connected to give a 240-120-volt three-wire low-tension winding, with the neutral grounded. To aid regulation, a number of transformers of the same size and type are usually connected together on the low tension side where conditions will permit. The secondary wire is generally No. 4 for the outside wires and No. 6 for the neutral, with No. 8 for the services. The maximum voltage drop from transformer to customer is kept within 2 volts whenever possible, since there is no way of regulating for voltage between these points. The pressure at the service is kept as near 120 volts as possible. Although standard 2,200-110-volt transformers are used, the pressure has been raised to 2,400 volts, and it is planned to raise it still further to 2,500 volts. This gives about 25 per cent higher core loss, but lowers the copper loss in both transformers and feeders about 29 per cent, and in addition gives nearly 14 per cent better regulation. The 2,400-volt system used 545.4 miles of high-tension wire, ranging in size from No. 6 to 350,000 c.m., and 1,137.7 miles of low-tension wire, varying from No. 6 to 4/0.

Losses in the feeder regulators were computed from tests made on each type used, in conjunction with load data from the station reports. Losses in distributing transformers were computed in the same way, using also recording ammeter charts taken at distributing points. Losses in the high-tension line were computed from the load data and line resistances of each feeder, and checked by recording voltmeter charts taken at the station and at each distributing point. Loss in low-tension line was estimated from line resistances and load data, and checked by recording voltmeter at the customers' services. Loss in the customers' meters was computed from tests on each type of meter in use.

A check on the various distributing losses is furnished by the difference in the power metered to the customer and that delivered to the distributing system. This amount proved to be slightly greater than the sum of the losses as computed, and the difference was added to the loss in low-tension system, since that loss was most difficult to determine with accuracy. There is also probably a small amount of stolen current included in the low-tension loss. The details of losses on the 2,400-volt commercial system follow:

	Efficiency, 1911	Loss. kw-hr.	Average loss. kw.
Feed regulators	98.6	178,500	20
Primary feeders	96.0	521,600	60
Distributing transformers	88.8	1,391,000	159
Core loss		960,000	110
Copper Loss		431,000	49

TABLE SHOWING LOSSES AND EFFICIENCIES FOR EACH PART OF THE SYSTEM.

	Per cent all-day efficiency	Total 1911 input, kw-hr.	Average 1911 input, kw.	Total 1911 loss, kw-hr.	Average 1911 loss, kw.	Per cent loss	Per cent of penstock input	Per cent of total loss
GENERATING SYSTEM	54.4	52,639,000	6009	23,990,300	2739	45.6	45.6	75.3
Penstocks	97.7	52,639,000	6009	1,214,900	139	2.3	2.3	3.8
Generating station	55.7	51,424,100	5870	22,775,400	2600	44.3	43.2	71.5
Water wheels	60.7	50,758,900	5795	19,944,400	2277	39.3	37.9	62.6
Generators	93.5	30,814,500	3518	1,990,800	227	6.5	3.8	6.2
Exciters	....	665,200	76	665,200	76	....	1.3	2.1
Station lights and control	....	175,000	20	175,000	20	....	0.3	0.5
TRANSMISSION SYSTEM	91.6	28,648,700	3270	2,413,500	276	8.4	4.6	7.6
Step up transformers	96.1	28,648,700	3270	1,126,000	129	3.9	2.1	3.5
Transmission lines	98.6	27,522,700	3141	378,000	43	1.4	0.7	1.2
Step-down transformers	96.6	27,144,700	3098	909,500	104	3.4	1.7	2.9
DISTRIBUTING SYSTEM	79.2	26,235,200	2994	5,448,700	622	20.8	10.3	17.1
City substation	98.7	26,235,200	2994	346,400	40	1.3	0.7	1.1
S. Lights and control	....	317,400	37	317,400	37	1.2	0.6	1.0
Switchboard meters	....	....	....	29,000	[illegible]	....	0.1	0.1
15,000-volt system	92.5	11,587,000	1323	868,600	99	7.5	1.6	2.7
15,000-volt lines	99.2	11,587,000	1323	93,500	11	0.8	0.2	0.3
15,000-volt transformers	93.2	11,493,500	1312	775,100	88	6.8	1.5	2.4
Series street lights	86.3	2,672,800	305	367,200	42	13.7	0.7	1.2
Transformers	95.0	2,672,800	305	133,700	15	5.0	0.3	0.4
Series circuits	90.8	2,539,100	290	233,500	27	9.2	0.4	0.7
Cluster street lights	79.1	1,486,000	170	310,000	35	20.9	0.6	1.0
Cluster transformers	87.8	1,486,000	170	181,000	21	12.2	0.3	0.6
Underground cables	90.1	1,305,000	149	129,000	15	9.9	0.2	0.4
2400-volt commercial system	76.2	13,178,400	1612	3,123,700	357	23.8	5.9	9.8
Feeder regulators	98.6	13,178,400	1612	178,500	20	1.4	0.3	0.6
Primary feeders	96.0	12,999,900	1592	521,600	60	4.0	1.0	1.6
Transformers	88.8	12,478,300	1532	1,391,000	159	11.2	2.6	4.4
Secondaries	92.9	11,087,300	1373	782,600	89	7.1	1.5	2.5
Customers' meters	97.6	10,304,700	1284	250,000	29	2.4	0.5	0.8
Direct-current system	35.7	673,200	77	432,800	49	64.2	0.8	1.4
Motor-generator	38.0	673,200	77	417,000	48	62.0	0.8	1.3
D-C. circuits	95.0	256,200	29	12,800	1	5.0	....	....
Customers' meters	98.8	243,400	28	3,000	....	1.2	....	....

SUMMARY: Total power loss........31,852,500 kw-hr. Average 3,636 kw.
Total power delivered to customers........17,304,900 " " 1,975 "
Total power delivered to street lamps........3,481,600 " " 398 "
Total delivered power........20,786,500 " " 2,373 "
Over-all efficiency, 39.5 per cent.
[1 kw-hr. at the customers' premises requires 1,364 gallons (5,163 liters) of water from Cedar Lake at average head of 590 feet (179.8m.)].

Secondaries	92.9	782,600	89
Customers' meters	97.6	250,000	29
Total for system	76.2	3,123,700	357

The cluster light system comprises 1,631 poles, lighting 25 miles of street and carrying 6,851 lamps of a total of 335,700 watts. This system is supplied from 720 kw. in transformers using 23 miles of primary wire carrying 2,400 volts and 98.4 miles of secondary wire in a 240 and 120-volt three-wire system. The voltage is changed from 120 volts to 8 volts in the base of the pole and 8-volt multiple lamps are used. Losses on this system were computed in a similar manner to those on the other distributing systems. They lack the check of integrating meters at the lamp, but were easier to compute on account of the constancy of the load. The transformer losses contain those from the pole-base transformers, which are 250-watt 8-volt transformers.

	Efficiency, 1911	Loss, kw-hr.	Average loss. kw.
Cluster light primaries	97.0	42,500	5
Cluster light secondaries	93.0	86,500	10
Cluster light transformers	87.8	181,000	21
Core loss	....	117,500	13
Copper loss	....	63,500	7
Total for system	79.1	310,000	35

SERIES STREET LIGHTING SYSTEM.

The series street light system comprises 683 miles of No. 6 wire divided into 29 circuits, lighting 601 miles of street. The circuits are connected two in series to 100-light air-cooled constant-current transformers. The voltage on the circuits varies with the number and kind of lamps from 2,500 volts to 5,000 volts. Altogether there are 692 6.6-ampere arc lamps, 5,315 40-candle-power tungsten lamps, and 199 300-candle-power tungsten lamps. Losses were computed in a similar manner to those on the cluster light system, and were as follows:

	Efficiency, 1911	Loss. kw-hr.	Average loss. kw.
Series lines	90.8	233,500	27
Constant current transformers	95.0	133,700	15
Core loss	....	63,900	7
Copper loss	....	69,800	8
Total for system	86.3	367,200	42

Important Considerations and Conclusions from Tests on Conduit.

(*Abstracted for* SOUTHERN ELECTRICIAN)

BY L. S. MONTGOMERY.

A SERIES of tests has recently been conducted at the Carnegie Institute of Technology at Pittsburg, Pa., to determine the relative merits of various conduits for electrical construction purposes. These tests were under direct charge of Robert B. Leighou, assistant professor of chemical properties of materials, and Hugh A. Calderwood, head instructor electrical equipment and construction, and point out interesting general facts concerning conduit as well as important conclusions from the tests regarding sherardized and electro-galvanized conduit. What follows is an abstract of the report, giving details of the tests:

An interior electric conduit system may be defined as a raceway in a building to provide for the ready introduction and removal of electric wires, and to provide efficient mechanical protection to them. The ideal conduit should occupy the least possible space, it should be rugged and mechanically strong, yet be easy to work and install, it should be durable, therefore must not readily yield to forces tending to destroy it, it should efficiently protect and preserve the insulation of wires contained in it; finally, it must be moderate in cost. No single substance of which such conduits might be made, possesses all of the above mentioned qualities. Some have certain qualities in suitable degree, but are conspicuously lacking in others, while another substance which possesses all the physical properties needed in the ideal conduit, would be absolutely prohibitive in cost.

MATERIALS EMPLOYED IN CONDUIT PIPES.

In the past, many substances, singly and in combinations, have been made into conduits, for example fibre, paper, rubber, moulded pulps and metal pipes lined with paper, wood or compositions, but all such have been practically abandoned. At the present time standard commercial butt wielded wrought iron, or steel pipe is the material employed in the manufacture of rigid metallic conduits. Although there are different types, and numerous makes of such conduits on the market, by common consent and necessity, there is a similarity in certain features. The pipes are all made a uniform length of ten feet; they are cleaned to remove scale, and specially treated to make the pipe smooth, both inside and outside; they are then coated with some substance intended to prevent rusting, to give them a pleasing and distinctive appearance and reduce friction between the inner surface of the conduit and the wires.

As has been said, no single substance has possession of all the qualities desirable in a conduit, but iron pipe possesses most of them, and it is to increase its ability to resist corrosion that the coating mentioned above is applied. The relative values of various types and makes of conduits, therefore, are chiefly determined by the degree with which they resist corrosion, and the general efficiency of their coatings. In order to arrive at correct conclusions regarding the qualities necessary in protective coatings for iron or steel pipes to be used as interior conduits for electric wires and to select suitable laboratory tests to determine the merits of samples of various coated pipes now on the market, careful consideration of the actual conditions which the finished product will encounter in service is necessary. These conditions vary widely—more widely today than at any previous time.

At its inception, the so-called "interior conduit system" was designed to solve the problems peculiar to concealing electric wires in fire-proofed buildings, for which purpose it is now in almost universal use and has no successful rival. In later years, however, its wider use has given rise to many new problems. Its many advantages with respect to ease of installation, permanency, mechanical protection to the wires, etc., have resulted in the extension of its field to

include all classes of buildings, and all classes of electric service. It is not only used in all sorts of buildings, but also out doors, on walls, etc., and underground, either buried in the earth or in tunnels and mines. It is also extensively used in marine work.

Interior conduit, therefore, is liable to attack by almost every conceivable destructive agency. It is exposed to the action of the weather in outdoor situations; it is subject to extremes of heat and cold; it may be buried in the earth or in cement, cinder concrete or lime-sand plasters; it may be exposed to corrosive vapors, coal smoke and gases; it may be attacked by oils, acids or alkalies, and always it must suffer mechanical injury in transportation, during installation and in service. The number, variety and severity of the destructive forces against which protection for the base metal must be provided, constitute a problem of no mean order, which requires for its solution the exercise of sound judgment and scientific knowledge in the selection of materials and invention of methods for applying the coating, and skill and integrity in manufacture, as well.

There is one point which should not be lost sight of or ignored, namely, the danger from the almost unavoidable penetration of vapors and liquids to the interior of the conduit, there to begin their attack, if they are deleterious in nature. It is obvious that adequate protective coating should be applied at this point as well as on the exterior. Some conduits have one kind of substance on the exterior wall and a different and decidedly less resistant coating, usually enamel, on the interior.

To sum up briefly, the qualities necessary in the ideal protective coating for rigid interior conduits are: (a) It should resist the general action known as corrosion. (b) It should be so flexible and well bonded with the base metal that it will not flake or scale off when the pipe is bent. (c) It should automatically resist the spread of corrosion from points of slight abrasion, such as scratches, nicks, etc. (d) It should cover the entire surface of the pipe, both interior and exterior. (e) It should be as thick as is commercially practicable to apply it. (f) It should not suffer serious injury from the ordinary incidents of transportation and installation. (g) It should not suffer from the wide extremes of temperature.

CONDUIT COATINGS IN COMMERCIAL USE.

At the present time there are two commonly used types of coatings for conduits, namely, zinc and enamel composed of oils, gums and mineral substances. Most authorities agree that zinc furnishes the most effective protection, as enamels are more or less lacking in the properties described above in sections a, c, f and g. Zinc coatings are applied in three distinct methods: "Hot galvanizing" in a bath of molten zinc. "Cold galvanizing" or electro-deposition, and "Sherardizing" or coating with zinz from commercial zinc dust. It is with the respective merits of the different galvanizing processes that the following statements will chiefly deal.

All of the conduits examined in the test from which data will be given here were of the ordinary butt-welded type—of the size known to the trade as "half inch" and were in good condition. Altogether four brands were examined. According to the manner of applying the zinc coating and these are divisible into two groups. First—sherardized, and second—electro-galvanized.

In the second group there are three brands well established on the market, which will be hereinafter referred to as E. G. No. 1; E. G. No. 2; E. G. No. 3. All of the samples examined were bought direct in the open market, or were obtained from consignments of conduit on building construction sites, and all samples were believed to be representative of their particular brands.

The ability which zinc has to furnish protection for iron depends fundamentally upon the fact that the solution pressure of zinc is greater than that of iron, and also that it is able to replace iron in iron salt formations, which latter is equivalent to saying it is electropositive to iron. The rate at which the coating is dissolved is, of course, influenced by its degree of positiveness to the iron base, and its freedom from segregated impurities which engenders local action. Such impurities serve as points to which the hydrogen ions may return and give off their positive charges, thus preventing an equilibrium from being established between the metal and the solvent. These conditions may be said to collectively determine the solubility of the coating. The greater the degree of positiveness and solution pressure of any coating, the greater is its ability to protect a space of iron for any reason bared, which the zinc coating may surround but not actually cover. On the other hand, it seems equally true that a coating may be so high in positive potential or solution pressure that it will be wastefully soluble. Actual illustrations of these points are shown in the case of the samples buried in cinders discussed later.

SUMMARY AND CONCLUSIONS ON TESTS.

Referring to the tests mentioned in the first part of this article, the principal features will be condensed into a few brief statements and it should be born in mind that the tests cover only electrogalvanized and sherardized coatings.

All of the coatings were found to be electropositive to iron, in the following order:

E. G. No. 2	0.488 Volt
E. G. No. 1	0.472 Volt
E. G. No. 3	0.450 Volt
Sherardized	0.296 Volt

Repeated experiments confirmed the above values. The question of the potential of the zinc-iron alloy forming the coating of iron articles galvanized by this process, has been the subject of much discussion, also whether or not the lower positive potential shown above, which is practically the same value found by the other investigations would indicate that sherardizing is a better protection than cold galvanizing. It seems from the test reasonable to assume that at this potential the protection afforded should extend over a longer period of time, and yield to corrosive influences less rapidly because the solution pressure is less intense. A fact which tends to confirm this assumption, is the appearance of the test pieces which were buried in cinders. Those which were electrogalvanized were denuded in large patches, while the sherardized samples, even with the customary paraffine coating previously removed, showed much less deterioration.

The evolution of hydrogen obtained in test also indicates that under similar corroding influences, the sherardized conduit should prove more lasting, as data obtained showed that the time required to strip the coating from the sample under test was 20.3 as against 15.0 minutes for the best electrogalvanized sample, and 6.66 minutes for the poorest.

The weight of the coatings per linear foot, is indica-

tive of its thickness, which should be as great as is commercially practicable to apply it. This does not mean that it should be as thick as is possible to apply it, as there is no doubt a point beyond which greater thickness would be undesirable owing to a tendency to flake, or fracture when the conduit is bent. The results of the weight determination showed the following order:

Sherardized—grams zinc per linear foot 3.0145
E. G. No. 2.—grams zinc per linear foot 1.7630
E. G. No. 3.—grams zinc per linear foot 1.6589
E. G. No. 1.—grams zinc per linear foot 1.0699

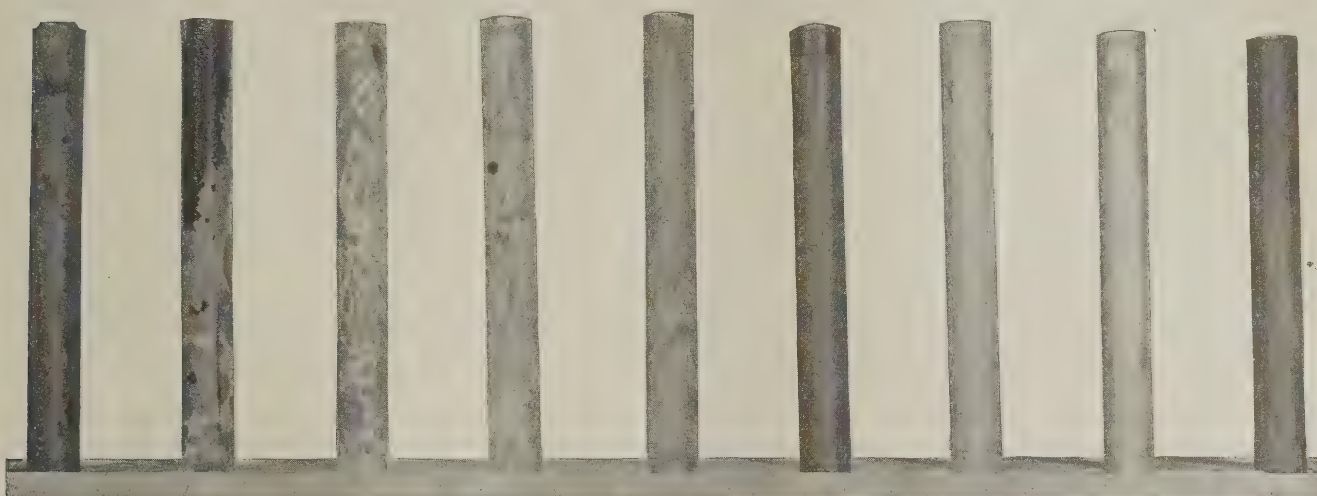
This shows a preponderance of zinc on the sherardized conduit as compared to any of the electrogalvanized samples, yet tests made by bending same, to the extent prescribed by Underwriter's Rules did not develop any tendency to flake off the coating.

As already stated, conduits are necessarily subjected to abuse, and mechanical injury. It follows that no matter how resistant to corrosion, how pure, how uniform, or how thick a coating might be when the conduit leaves the factory, if it yields readily to the mechanical abuse it receives, then it cannot be depended upon to efficiently protect the underlying metal from corrosion, in service. Very little has been published about the properties of zinc-iron alloy and the abrasion developed surprising results, as the sherardized sample having at the beginning roughly three times the initial weight of zinc possessed by the poorest sample of electrogalvanized, showed at the end of the test over twenty-two times as much remaining; with about three and three-fourths times as much as the best electrogalvanized at the beginning, it had five times as much at the end.

Another way of considering this, is to compare the percentage of initial coating retained by each conduit, which is 45.4 per cent by sherardized, as against 5.4 per cent by the poorest electrogalvanized, and 15.8 per cent by the best.

Conduits are frequently called upon to withstand conditions which are extremely corrosive, one illustration of such conditions being intimate contact with cinders, either as an ingredient of concrete or otherwise. Test pieces which were taken from the various brands and buried at an equal depth in a cinder pile which was exposed to the weather, appeared upon removal as follows: The electrogalvanized samples showed large patches entirely denuded of zinc. The area of these denuded patches was of course greatest in the case of that brand which by a previous determination was found to contain the least zinc per linear foot.

In the case of the sherardized test pieces there seemed to be no point from which zinc was entirely removed, even on that test piece which had been previously freed of its paraffine. Of all the test pieces the sherardized sample which had been allowed to retain its natural paraffine coating was in the best condition. Of course, all test pieces showed some rust, but there was considerable difference in the character and amount of the rust. The rust on the electro-galvanized samples was of a scaly nature, showing the characteristic pit marks of destructive corrosion, while that found on the sherardized sample, although it spread over a considerable amount of the surface, it was not deep and scaly, being presumably the rust produced by the oxidation of the iron thrown out from the alloy. In view of the above results it seems reasonable to assume that final destruction would be longest deferred in the case of the sherardized conduit.



SPECIMENS BURIED IN CINDER PILE AND IN MOIST YELLOW CLAY FOR 28 DAYS. THE FIVE TO LEFT FROM CINDER PILE THE FOUR TO RIGHT FROM CLAY.

At the top of page 382 of the September issue, it was stated that J. J. Schultheiser is superintendent of line construction in charge of transmission lines and F. H. Sloan is civil engineer in charge of field engineering and buildings for the Northern Contracting Company, now completing the Tallulah Falls plant of the Georgia Railway & Power Company. It should have been stated in this connection that Messrs. Schultheiser and Sloan have charge of transmission lines and sub-stations, etc., under the Atlanta office while at Tallulah Falls, Murray Blanchard is in charge of the civil engineering department and R. L. Caldwell is superintendent of construction, both under the resident engineer, Mr. Chas. D. Adsit.

The cut of a new semi-indirect lighting unit shown on page 460 of the October issue became reversed in the process of printing and in some issues the illustration shows the unit upside down. This unit has been designed and is now placed on the market by the Haskins Glass Company, Wheeling, West Virginia.

Operation of Sewage and Drainage Pumping Plant at East St. Louis.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

BY HOWARD F. SMITH.

THE preparation made by the City of St. Louis during the past few years for handling the sewage and rainfall within the city limits, during periods of high water, as recently experienced along the Mississippi river, has proved to be of the greatest value and a wonderful asset to the city. The improvement of a system of sewers and drains, together with a pumping plant, the construction details of which were described in the September, 1911, issue of SOUTHERN ELECTRICIAN.

The area drained at the present time is six square miles and contracts recently let will increase this to nine square miles and contemplated improvements will further increase the territory drained about 50 per cent. The sewer mains installed and under contract range from 10½ feet reinforced concrete sewer to 36-inch sewer of plain concrete having a total length of about 15 miles, which, together with smaller vitrified pipe sewers, complete the network.

The installation work in the territory covered by the city was most difficult, due to quicksand and extra precaution must be taken by the contractor and inspectors to insure a continuous sewer, without breaks of any nature, as a small opening will permit the sand to flow until the sewer is completely filled or the opening is repaired. All sewers are circular and of special design to meet the rigid requirements. Charles Dickens once described the territory covered in part by East St. Louis in rather uncomplimentary terms, but the recent visit of his son found a city of 60,000 people with modern improvements made possible, largely through the efforts of the engineer.

THE PUMPING PLANT.

The pumping plant in brief consists of an engine room, having a floor space of 31 feet by 112 feet, on which is located five 18½ inch by 20-inch Rathbun Jones three-cylinder, vertical, single-acting gas engines, each rated at 290 hp. and direct connected to 48-inch centrifugal pumps of the Allis Chalmers make and designed for drainage purposes. Also two 15x16-inch engines as outlined above are connected to 36-inch pumps and rated at 200 hp. The engines and pumps are located on lines running at 45 degrees with the building lines, which permits of the maximum space being occupied by the machinery and resulted in a great saving inasmuch as the foundations extended some 30 feet below the surface and in quicksand. At the western end of the engine room is a small reinforced concrete gallery of cantilever design nine feet above the main floor, upon which the electrical apparatus is located. This consists of a 11x13 inch two-cylinder vertical gas engine direct connected to a 35-kw. three-wire D. C. 120-240-volt Westinghouse generator; a motor generator set of 25-kw. capacity operated with outside power and the switchboard. All engines, pumps, valves and equipment are controlled from this level, which is connected with the operating platform of the engines.

The air compressor, vacuum pumps, sump pump and filters are located on the main floor, while the office, storeroom and visitors' gallery are located on a level with the surface of the ground, about 22 feet above the main floor. A ten-ton Whiting three-motor crane travels the full length of the engine room, permitting easy handling of the apparatus.

Each pump is provided with hydraulically operated valves, both on the suction and discharge lines, and a main by-pass valve 10½ feet in diameter allows the water to flow by gravity past the pumping plant during periods of low water in the river. This large valve is operated by worm gear and a 15-hp. motor. The total connected electrical load for auxiliary power and light is 80 kw.

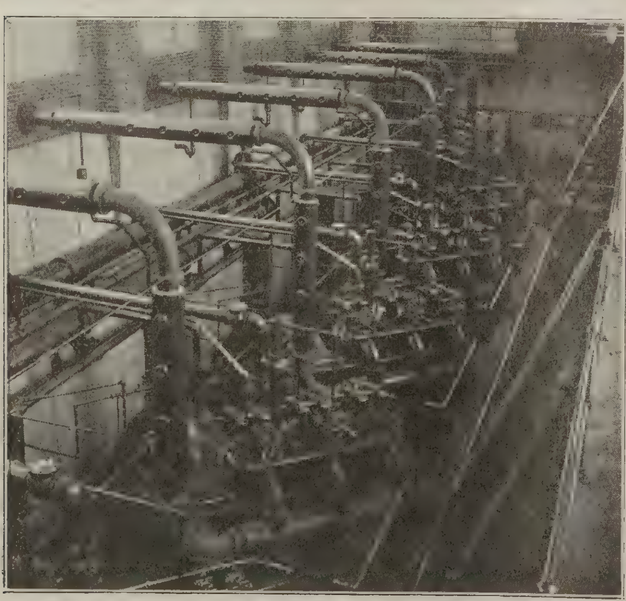


FIG. 1. ENGINE AND PUMPS AT PUMPING PLANT, EAST ST. LOUIS, MO.

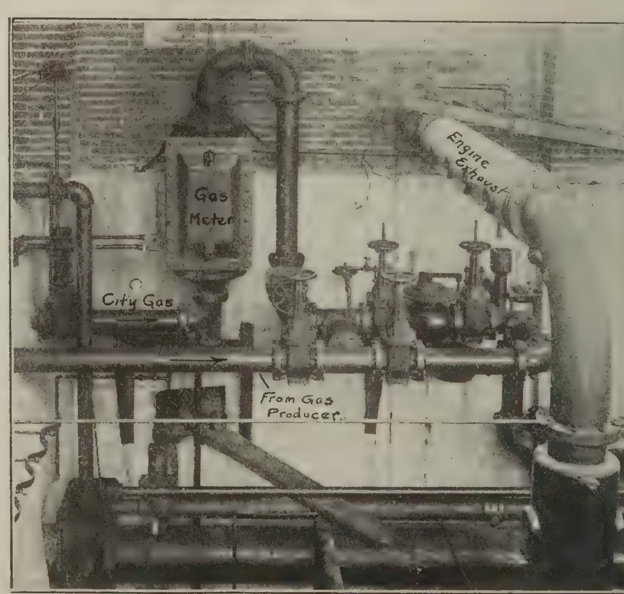


FIG. 2. CONNECTIONS FOR THOMAS GAS METER FOR 40,000 CUBIC FEET OF GAS PER HOUR.

The producer room is 20x31 feet and separated from the engine room by a brick partition. A 500-hp. suction type producer furnishes gas. The producer is provided with a scrubber, tar extractor and moisture separator and can be operated with either anthracite or bituminous coal. An office, storeroom and toilet above ground completes the equipment and gives the building a pleasing appearance.

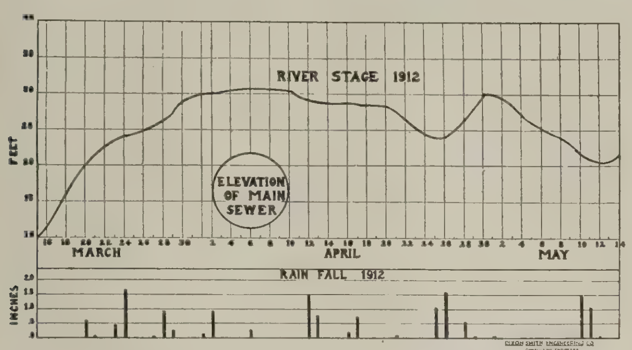


FIG. 3. CHART SHOWING STAGES OF RIVER DURING MARCH, APRIL AND MAY, 1912.

The St. Clair County Gas Company has a 6-inch high pressure gas main leading into the building with pressure reducer and meter which provides additional and an independent source of fuel. This meter is of the Thomas design manufactured by the Cutler Hammer Co., and gives the operator a graphic chart showing the amount of gas used at any time, together with dial records of the total amount of gas used, which permits the cutting out immediately of any engine using more than the necessary amount of fuel, until the necessary adjustments can be made. This meter employs a new and novel method, and actually weighs the gas as it passes through and gives the quantity flowing in place of the volume, and is independent of the pressure or temperature. The gas in flowing through the meter is heated three degrees by electrical energy passing through coils in the interior of the meter and this electrical energy required is in dirct proportion to the amount of gas thus heated.

The specific heat of a pound of illuminating or other gas is practically constant within the ordinary range of temperature and pressures and the electrical energy required to heat the gas as it passes through the meter is measured by a wattmeter, which is calibrated to read in feet of gas as customarily sold. The watts input is also measured by a graphically recording wattmeter calibrated as above which furnishes a continuous operating chart.

OPERATION OF PUMPING PLANT.

The primary function of the plant is to handle a large amount of water during periods of high river and immediately during rains, no storage reservoir being provided. Two independent sources of both gas and electricity with plenty of spare equipment practically guarantees the operation when needed. About two minutes notice sees the plant in operation. The operating force when running consists of a chief engineer and three crews of three men each, under the direction of the board of local improvements. Pumping is started when the river reaches a stage of about 19 feet and continues during high water.

The equipment was given a ten days' trial during December, 1911, and proved more than satisfactory, and actual operations were started the middle of March and continued until the last of June of this year, and during the period when most of the cities along the Mississippi were flooded, East St. Louis was enjoying normal conditions. During the month of April approximately 835 million gallons of water and sewage was pumped against an average static head of 13 inches. The fuel cost for pumping with gas purchased from the outside was below $1.00 per million gallons pumped. The total operating expense was approximately $2.40 per million gallons pumped or at the rate of one cent for each 4,000 gallons of water handled.

The system was first worked out by Mr. E. T. Adams of Milwaukee, and is incorporated in an ordinance for the city about eight years ago, and has since been redesigned to meet the more modern design of apparatus and installed under the direction of the writer as a member of the firm of Dixon-Smith Engineering Company, Consulting Engineers of St. Louis.

Care and Operation of Transformers.

BY W. M. M'CONAHEY.

Methods of Removing Moisture and Effects of Over Loads on Oil, Water and Air Cooled Types.

SUCH rapid strides have been made in electrical transmission with accompanying increase in sizes of units, voltages used and absolute dependence placed in generating and substations that the operation and care of transformers is an all-important subject. In what follows an abstract of a most complete treatment of the subject is presented as prepared for and delivered at the Seattle convention of the National Electric Light Association by the above author.

There are two essentials to be considered in the design of transformers, namely, insulation and heating. There are minor points to be taken into account, such as efficiency, regulation, adaptability to various classes of service, etc., but the only practical effect they have is to modify the proportions of the design. The insulation must be of good quality, of sufficient amount, properly distributed, and the provisions for ventilating the windings and dissipating the heat must be such as will keep the temperature within reasonable limits. Assuming that these conditions have been met by the manufacturer, it is seen at once that the operating man must do his share towards maintaining the insulation in good condition and preventing excessive heating by prolonged heavy overloads. With intelligent and systematic care, there is practically no end to the life of a well-designed modern transformer.

The principal insulating material used in transformer manufacture, known as "press-board" or "fuller-board," is of a fibrous nature. It is made up in large sheets varying in thickness from a few mils to about 1/8 of an inch, although in large transformers it is generally not used in thickness of less than 1/16 of an inch. It is cut and formed into the proper shapes and assembled with the

coils so as to give the necessary dielectric strength in the various parts. From this it is seen that the fuller-board is depended upon to furnish the insulation among the various parts of the windings and between the windings and ground, and that it must be maintained in good insulating condition if the transformer is to have long life and continue to operate without giving trouble.

Since fuller-board is of a fibrous nature, it has a tendency to absorb moisture wherever it is present. Unfortunately the more moisture that is absorbed the weaker becomes the dielectric strength. No satisfactory method has yet been devised for treating the fuller-board so as to make it entirely impervious to moisture, nor has any satisfactory substitute been found that will meet the requirements. It is necessary, therefore, in order to protect the insulation to use such means in operation as will prevent as much as possible the entrance of moisture into the transformer case and to remove any that may enter before it has had time to cause serious trouble. Formerly it was customary to ship transformers packed separately from their tanks. When shipped in this manner it was practically impossible to prevent the insulation from absorbing moisture, even when special methods of packing were resorted to. Such schemes as packing in tin-lined cases or placing calcium-chloride inside of packing cases never proved very satisfactory, so that before putting a transformer into service it was nearly always necessary to dry it out. This required time and care and a certain degree of expert knowledge which made it very desirable that some method of shipment be devised which would make drying out before installing unnecessary. This is now accomplished by bracing the transformer securely in its tank, filling the tank with oil and shipping in this manner. The only limit imposed upon this method of shipment is the inability of the railroads to handle very large sizes because of insufficient clearances. This has been overcome to a considerable extent by the use of a special form of "cut-out" car with the floor much lower than that of an ordinary flat car.

When a transformer is shipped in its own tank with the oil it should arrive at destination with the insulation and oil practically dry and free from moisture. In order to make sure of this, however, it is best to draw a few samples of oil from the bottom of the tank and test them. The best way to make the test is to use some standard form of testing cup and a variable ratio testing transformer by means of which the voltage can be raised gradually. The cup is filled with a sample of the oil, the gap is adjusted to a fixed length with a micrometer screw and the voltage raised until a spark jumps across the gap through the oil. It is customary to set the gap at about 150 mils, and with such a setting good oil will show break-down of not less than 30,000 volts, *i. e.*, 200 volts per mil of gap for an average of ten tests. A variable ratio testing transformer may not always be available, but any company using transformers should not be without an oil-testing cup, which is an inexpensive piece of apparatus. If no means of varying the voltage is at hand, so that it is necessary to use a fixed voltage for making the test the gap should be set to give 200 volts for every mil of separation and break-down should not occur at this setting. In making tests in this way, however, it is not advisable to use a testing voltage below 6,600 volts. If the tests on samples of oil taken from the transformer shipped in its tank with the oil are satisfactory, it is a practically sure indication that the transformer is dry and ready to put into service.

Cleanliness is essential to good service, and it is important for the life of the transformer, particularly if it be of high voltage, that the tank be closed up tightly so as entirely to exclude dust and dirt. This is done by packing tightly around all outlet bushings and placing gaskets under the cover, and also under hand-hole and man-hole covers. In very large transformers the gaskets are often made so that the tank can be closed up practically air-tight, but in medium and small sizes the gaskets are generally made of felt or hemp treated with a moisture-proof compound. It is surprising how much dirt can gradually work its way through a very small crack, so that it should not be taken for granted that small openings are harmless. To allow a transformer to operate with a loose-fitting cover or with openings unclosed is inexcusable negligence which will be paid for by a shortened transformer life.

After the transformer has been installed and put in operation successfully, it should not be expected to operate continuously thereafter without further attention. A periodical inspection should be made about once every six months. Such an inspection should include a test of a sample of the oil drawn from the bottom of the tank and an examination of the interior. If a test of the oil shows the presence of too much moisture, or an inspection shows a deposit of dirt or slime in the transformer the oil should be drawn off and filtered and de-hydrated, and the transformer and interior of the tank should be thoroughly cleaned with dry clean waste. The ventilating ducts can generally be cleared by squirting dry oil through them. If the transformer is water-cooled the cooling coils should be examined to find out whether any deposit has been formed on them by the oil. Some oils will form a coating on the cooling coils, which acts as a heat insulator and causes the transformer to run hot. This deposit can be removed only by scraping and rubbing the coils until they are clean. Good transformer oils, as they are supplied today, will form little or no deposit. They are also reasonably clear, so that by the use of an incandescent lamp a very good inspection of the upper part of the windings can generally be made without the necessity and inconvenience of lowering the oil until the coils are exposed.

If the oil in a transformer is found to be in a dirty condition or to be forming a deposit, it should be filtered, and if it is found to contain moisture, steps should be taken at once to remove this moisture. The filtering process can be performed easily by passing the oil through two or three thicknesses of bolting cloth. One passage through the cloth will nearly always be found sufficient to remove all the dirt or deposit.

The removal of moisture is not such an easy task. Various make-shift schemes have been tried from time to time, but all of them are far from satisfactory. Some of these schemes are: Placing bags of dry lime in the oil, passing hot air through the oil, or heating the oil so as to vaporize the moisture and drive it off. In order to remove the moisture completely and leave the oil in first-class condition, it should be passed through some standard form of de-hydrator designed particularly for that purpose. Probably the best form of this class of apparatus is that known as the filter-press type. In this type the oil is pumped through several thicknesses of a specially prepared paper. The paper has the peculiar faculty of allowing the oil to pass through freely, while at the same time retaining every bit of moisture until it becomes saturated. When the paper

approaches saturation, it should be removed and replaced by fresh dry paper. This is the best method that has yet been devised for removing moisture from oil. It is very simple and removes the moisture entirely, leaving the oil in a clean, dry condition.

An exceedingly simple and satisfactory way of keeping the oil clean and dry is to connect a small de-hydrator outfit to a transformer tank in such a way that the oil can be pumped from the bottom of the tank through the de-hydrator and back again into the tank at the top. The connection at the bottom can be made through the oil valve which is provided with all transformers. The necessary connections can be made and the de-hydrator put into service without in any way interfering with the operation of the transformer. A small, cheap de-hydrator having a capacity of about two gallons per minute can be had, which is particularly suitable for this work. It can be kept in operation continuously until the oil is clean and dry. This method of caring for the oil should appeal to operating men because of its simplicity and convenience.

Assuming that the necessary care is taken to keep the transformers clean and dry, it is equally important that it be not overloaded to such an extent that the insulation is damaged by excessive heating of the coils. Insulation will not stand prolonged heating at a temperature much above 100 degrees C. without permanent injury. It is practically out of the question to determine the actual temperature of the copper, which is the hottest part, so that about the only guide the operating man has is the temperature of the oil. It is generally customary for manufacturers to guarantee that the temperature rise of the windings of power transformers when operating at normal load will not exceed 40 degrees C. above the temperature of the cooling medium (air or water). Going a little further and analyzing this 40-degree drop, we find that it may be divided up approximately as follows: Copper to oil, 10 degrees, and from oil through the tank to the air or from the oil through the cooling oil to the water, 30 degrees. These drops will vary considerably with different transformers, but the figures given represent a fair average. Assuming that the iron loss and copper loss are equal, if the load is increased 25 per cent the copper loss will be increased 56 per cent, while the iron loss will remain constant, so that the total loss will be increased 28 per cent. Roughly speaking, the different drops will be proportional to the amount of heat taken away, so that the drop from copper to oil for 25 per cent overload will be increased 56 per cent and that through the oil to the cooling medium 28 per cent. Applying these increases, we find that the normal load drops of 10 degrees from copper to oil and 30 degrees from oil to cooling medium are increased to approximately 15½ degrees and 38½ degrees respectively, or a total of approximately 54 degrees. That is, increasing the load 25 per cent has increased the temperature rise of the windings from 40 degrees to 54 degrees. The standard temperature guarantees for power transformers when operating continuously at 25 per cent overload is 55 degrees.

If the windings are well ventilated the maximum temperature will not exceed the average by more than a small amount, but if they are poorly ventilated there may be a wide difference between the maximum and average temperatures. From the above discussion it will be noted that as the load is increased the drop from copper to oil increases rapidly, so that for heavy overloads the temperature of the copper is much above that of the oil. For this reason, if it is necessary to put a heavy overload on a transformer for several hours, some judgment must be exercised in trying to determine from the temperature of the oil what the temperature of the windings is. If this temperature (not temperature rise) is allowed to get much beyond 100 degrees C., there is danger of the insulation being permanently injured.

There is quite a difference between a prolonged overload and one of short duration. Oil has the capacity of storing considerable heat, so that if a transformer is operated at a moderate temperature quite a heavy overload can be thrown on suddenly and carried for such a time as is required to raise the oil to a temperature beyond which it is not safe to go because the temperature of the windings has approached the limit of safety. The thermal capacity of oil is such that one kw. will raise the temperature of 11 gallons 1 degree C. per minute. Setting this in the form of an equation, we have $t = 11 \times W \times T)/G$, in which t = temperature in degrees C., kw = loss, T = time in minutes and G = gallons of oil. During the time that heat is being stored in the oil it is also being taken up by the circulating air if the transformer is self-cooling, or by the cooling water if water-cooled. While the transformer is being heated up under a steady load the rate of storing heat gradually decreases and the rate of giving up heat to the cooling medium gradually increases until finally a steady condition is reached in which no heat is stored up, but all is given to the cooling medium. During the heating-up process if the transformer is under heavy overload the temperature of the oil should be watched and should not be allowed to exceed a value, which, according to the approximate method given above for calculating temperature drop through the copper and oil, indicates a winding temperature exceeding 100 degrees C.

Self-cooling transformers can now be built in sizes up to about 2,000 or 3,000-kw., depending upon the voltage and frequency. These large sizes are particularly applicable where it is desirable to transform large amounts of power without artificial cooling and with a minimum amount of attendance.

The output for which water-cooled transformers can be built is limited only by the weight and the mechanical dimensions which make handling or transportation difficult. In very large sizes, it is sometimes necessary to ship the transformer in a more or less knocked-down condition and assemble the parts at destination. The reason that water-cooled transformers can be built in such large sizes is that cooling coils with sufficient radiating service to take care of the large amounts of heat generated can be made without trouble. Water, because of its very high thermal capacity, is particularly suitable as a cooling medium. One kw. will raise 3.8 gallons of water 1 degree C. in one minute. Ordinarily the water rate is ¼ gallon per minute per kw-loss, which gives a temperature rise of 15 degrees C. from the inlet to the outlet of the cooling-coil.

Increasing the water rate decreases its temperature rise in inverse ratio and the temperature of the windings is lowered approximately one-half the amount by which the temperature rise of the water is lowered. On the other hand, decreasing the water rate increases its temperature rise in inverse ratio and the temperature of the windings is raised approximately one-half the amount by which the temperature rise of the water is increased. As an example, if the water rate is increased from ¼ to ⅜ of a gallon per kw.-loss, the temperature rise of the water will be decreased

from 15 degrees C. to 10 degrees C. The average temperature of the water in the cooling coil is 2½ degrees lower for the ⅜-gallon rate than for the ¼-gallon rate, and therefore the temperature of the windings is also 2½ degrees lower. Thus it is seen that no very great gain is made by increasing the water rate. If, however, a heavy overload is placed on the transformer so that the temperature rise of the water is considerably increased, an increase in the water rate will help materially.

Some kinds of water will gradually form a deposit on the inside of the cooling coil, which will act more or less as a heat insulator, and may in extreme cases close up the opening in the coils entirely. The presence of the deposit can be detected by a decreased flow and an increased temperature rise of the water or by an increase in the temperature of the transformer. It can generally be removed by passing a solution of hydro-chloric acid through the cooling coils.

A water-cooled transformer should not be operated except for a very short time without the circulation of water through the cooling coils. The transformer will heat up very rapidly and will soon reach a dangerous temperature. It cannot even be operated in this manner for any length of time without load, because the iron loss in itself is sufficient to raise the temperature above the danger point. In order to guarantee against overheating due to the stoppage of the flow of water, it is customary to equip water-cooled transformers with alarm contact thermometers, to which alarm bells can be wired for the purpose of giving warning if the temperature should rise too high.

We will now say a few words about air-blast transformers, which form a class by themselves. Their use is comparatively limited, being confined chiefly to a few large centers. For cooling purposes there are required about 150 cubic feet of air per minute per kw. of loss. The air pressure required varies from about ½ to 1 ounce, depending upon the size of the transformer. If the air-pressure is shut off from an air-blast transformer it can carry full load for only a few minutes before reaching a dangerous temperature. This will be understood easily when it is remembered that there is no oil to store heat, and since there is very little radiation, practically all the heat generated in the windings has to be stored in the copper. The thermal capacity of copper is very low, and therefore it heats up very rapidly.

Starting cold and throwing on full load, with the air-blast going, an air-blast transformer will reach steady temperature conditions in about two hours, while an oil-cooled transformer would require probably six to ten times as long. Because of the rapid heating-up of the windings, an air blast transformer cannot safely carry a heavy overload for more than a few minutes. The temperature rise of the windings under normal operation varies approximately in the same ratio as the copper loss. For example, if the temperature rise is 35 degrees C. under full load it will be approximately 55 degrees C. at 25 per cent overload. This type of transformer should not be wound for voltages exceeding 35,000 volts. Beyond this it is impractical to go because of the insulation difficulties encountered.

When two or more transformers are to be operated in parallel or in banks on a polyphase circuit, it is necessary to know their polarity in order that they may be connected up properly. If all of the transformers are alike, they may have the same polarity, but if some of them are of different design or were made by different manufacturers, their polarity may be different.

In order to secure perfect parallel operation between two transformers they should have exactly the same ratio of high tension to low-tension turns, the same I.R. drop, an dthe same impedance drop. For all practical purposes, however, two transformers having the same ratio of turns and approximately the same impedance will operate satisfactorily in parallel even if the I.R. drops are different. Duplicate transformers will, of course, have the same characteristics and share the load equally. Two transformers of different make or different size will probably have different characteristics, so that when parallel operation is attempted, measurements should be made to determine if each will carry approximately its share of the load. As a general rule transformers differing widely in size should not be operated in parallel, particularly if the smaller size has much lower impedance than the larger. Where the impedances differ the load on the transformer with the smaller impedance will increase and that on the one with the larger impedance will decrease until the two impedances become equal. For example, if a load of 400 kw. be placed on a bank of two transformers, one of 100-kw. capacity with 3 per cent impedance and the other of 300-kw. capacity with 5 per cent impedance, the load on the 100-kw. will be increased to approximately 145 kw., while the load on the 300-kw. will be decreased to approximately 255 kw. In other words, the impedance of a transformer varies directly with the load, so that the load on the 100-kw. transformer increases and that on the 300-kw. decreases until the impedances become equal.

It is not easy for manufacturers to design transformers to operate in parallel when the sizes differ widely and if tap voltages have to be considered the problem becomes much more difficult, the price may be increased considerably and the performances will probably not be as good as for a standard design.

When two transformers are connected in V on a three-phase circuit, the capacity is $1 / \sqrt{3} = 58$ per cent of the capacity of three similar transformers connected in delta. This is due to the fact that for the delta connection the current and voltage of each transformer are in phase with each other, while for the V connection the current and voltage of each transformer are 30 degrees out of phase with each other. When two transformers connected in V are operated in parallel with three transformers connected in delta, one of the transformers will take more than its share of the load.

Convention of the Electric Vehicle Association of America.

The Electrical Vehicle Association of America held its third annual convention at Boston, Mass., on Tuesday and Wednesday, October 8 and 9. This convention was held during the 1912 Boston Electric Show and in the same building. On this account considerable interest was manifested in the convention and the attendance was a clear indication of the interest now generally found in the electricle vehicle industry. The members of the association and the guests present for the convention particularly numbered about 100. An interesting program was carried out and in connection with all the papers presented, a hearty and thorough discussion was participated in by all who listened to them.

The address of the president, Mr. W. H. Blood, Jr., reviewed the work of the association and its growth since its organization two years ago. He showed from operating data that electrical vehicles are now used more days in a year than any other transportation device, and also pointed out that the electrical vehicle, on account of its present reliability, is fast replacing the horse dray in the larger cities.

The membership committee reported a total membership of 317, an increase of 120 over the membership a year ago. The largest percentage of the membership is distributed along the Atlantic slope and Gulf States, the membership in this district being 72 per cent of the total, the remaining 28 per cent being located in the middle states, and west of the Mississippi. Mention was made of the activity now taking place through branches in New England and at Chicago.

An interesting paper of the convention was delivered by C. E. Michel, entitled, "Where We Stand Today." In his paper Mr. Michel emphasized that the application of the electrical vehicle is as clearly defined as any other transportation unit, and that both central station and the public appreciate the necessity for the electric truck and pleasure vehicle. He further commented upon the competition between electric vehicle and the horse and believed that the overcoming of this competition must rest largely in overcoming the inherited habit of using the horse for delivery purposes.

As to the growth of the industry and the profitable results to central stations, he referred to St. Louis, where there has been an increase in charging revenue at the rate of $1,000 per month, or 37 per cent over 1911. In New York electric vehicles increased in number 35 per cent during the last year, and in Chicago equal results were shown, where during the month of June, 200 electric commercial vehicles were under order and undelivered. The discussion by a representative of the Commonwealth Edison Co., of Chicago, brought out the fact that during the past two years the number of electric trucks in Chicago had increased from 81 to 400. A large garage is now established, which will care for 300 commercial and pleasure vehicles at one time.

Following the above paper Mr. R. McAllister Lloyd presented a paper on "Street Conditions and the Electric Vehicle." The author believed that electric vehicle maintenance would be largely reduced if blocks could be eliminated and holes in streets filled, with trolley tracks and rails maintained flush with the street surface. He further stated that a general improvement of streets and roads is necessary to keep down maintenance costs.

"The Electric Vehicle in Denver" was the subject of a paper by Dr. M. Ekstromer. He reviewed the establishing of a department of electric vehicle storage battery engineering in the early part of 1910 by the Denver Gas & Electric Co., stating that the company sells no electric vehicles directly. He stated that in June, 1910, there were three commercial and 480 electric pleasure vehicles in the city, while now there are 57 commercial electric vehicles in service and 850 pleasure vehicles of the electric type. The vehicle load in about 2,160,000 K. W. hours with a revenue of about $64,800 per year.

Mr. C. L. Edgar, of Boston, presented the report of the publicity committee and explained through lantern slides the plans for handling the advertising campaign now being carried on by the association. The campaign entails an expenditure of about $38,000, and calls for 432 insertions in publications having a combined circulation of nearly 3,600,000 copies. Credit was given the Electric Storage Battery Co., and other manufacturers for their assistance in this campaign. It is estimated that the total number of readers of the 42 trade journals is 14,000,000. As an indication of the interest shown in this publicity, the association reports 702 inquiries at the time of printing their report. The committee recommended that the association continue a campaign for another year.

The cost of motor trucking was the subject of a paper presented by Dr. Harold Pender and H. F. Thomason, of the electrical engineering department of the Massachusetts Institute of Technology. The paper contains 36 pages and gives data and tables on the cost of motor trucking. In addition to this there are tables on a number of trucks represented in the report, giving age, length of time covered, mileage and days of use of the equipment.

"The Progress of Electric Trucks in America" was the subject of a paper by E. S. Faljambe. It was shown that 2,500 commercial motor vehicles were in use in 1908, and over 30,000 at the present time. This number includes both gasoline and electric machines. A number of applications were outlined, and it was shown that in a brewery establishment of New York cost of delivery per barrel has been reduced by the use of electric trucks, so that a saving of $800 per year over horse-drawn trucks is effected.

"The Possibilities of the Electric Vehicle" was the subject of a paper presented by S. B. Thompson, in which the author took up the future of the electric vehicle, stating that the greatest movement can be looked for in the large city.

Following this paper J. T. Hutchins, of Rochester, N. Y., presented the recommendation of the committee on operating records.

"Rates and Charging Stations" was the subject reported on by J. F. Gilchrist, of Chicago. This report advocated the use of a public garage, lower maximum rates, a separation of the energy charge from the garage charge, and the use of a uniform sign for garage service. Greater co-operation was advocated between the central station and the heavily burdened manufacturer.

Mr. William Pencoast, chairman of the committee on education, voiced the need of better trained garage and electric vehicle factory employes and took up in some detail a course in electrical vehicles by the Technical High School of Cleveland, Ohio.

The committee on standardization advised that the shell of the charging plug be made of high carbon or case hardened steel, and the adoption of the association plug as the standard in vehicle practice. It was voted after the reading of this report that the association's standard charging plug be recommended for general use.

"The Electric Vehicles From an Insurance Standpoint" was taken up by Carl H. Clark. In this paper the causes of electrical vehicle fires was discussed as follows: Overheating of resistor coils by accidental closing of the switch while the car is at rest; heat given off by water or snow; chafing or bruising of insulation and ignition while charging. The remedy suggested was some means of practically compelling the withdrawal of the plug when leaving car, or a positive lock on the control lever when in a neutral position, resistors better ventilated and a proper distance from wood work, wires run in conduit or fibre tubes, elimi-

nation of all loose and swinging wires, and charging without presence of open flame. The discussion developed the fact that the Edison Co., of Boston, is rewiring its cars in accordance with the most improved practice.

"The Standardization of Electric Vehicles" was the subject of a paper presented by Alexander Churchward, in which recommendations were made for certain standard maximum speed for electrical vehicles. The speed recommended in miles per hour were as follows: Closed coupes 18 with solid and 19 with solid cushion tires; open Victoria types 20 and 19 miles. Speed for commercial vehicles should vary from 6½ in six-tone equipments to 12 to 13 in 1,000 pounds units.

The Chicago and New England branches of the association rendered annual reports through their chairmen, Messrs. George A. Jones and Wells E. Holmes.

The following officers were elected for the coming year: Arthur Williams, of the New York Edison Co., president; F. W. Smith, of the United Electric Light & Power Co., New York, vice-president; Hewey Robinson, New York Edison Co., secretary; Day Baker, of the General Vehicle Co., of Boston, treasurer. Directors: W. G. Bee, W. H. Blood, G. S. Mansfield, G. H. Kelley and P. G. Wagoner.

The Boston Electric Show and the New York Electrical Exposition.

At the time this report was written two important and inspiring electrical exhibitions were underway in two cities noted for their strides in the adoption of electrical service. We refer to the Boston Electric Show which opened September 28th to continue for an entire month, and the New York Electrical Exposition and Automobile Show, which opened October 9th and closed on the 19th.

The Boston Electric Show sets a precedent for shows of its nature, both in regard to elaborateness and preparation and in the time that the exhibitions were open to those interested. The show is held under the auspices of the Electrical Illuminating Co., of Boston, and through its very nature is of decided educational benefit to not only those living in Boston, but in all of New England, in view of the fact that over 300 central stations are co-operating with the Boston company in making possible the extensive exhibits. There were present some 200 individual exhibitors to show and explain the use and design of every conceivable form of electrical current consuming device.

The special illumination on the outside, as well as the inside of the Mechanic Building, where the electric show was held, measured up to standards of the latest practice as designed by Dr. Louis Bell, consulting engineer for the Boston Edison Company. Over 30,000 electric lamps of various colors were used in outlining the building, while the streets leading to it were illuminated by some 44-lamp standard, on which were mounted over 170 flaming arc lamps burning in green and pink colors. Inside the Exhibition Hall 25,000 lamps of 150,000-candlepower were used.

A feature of the exhibit is a display of electrically operated apparatus used on the farm and in the home, which was especially arranged by the Edison Illuminating Co., of Boston.

As already mentioned in another section of this issue, the Electric Vehicle Association held its convention in the same building and had an exhibit where a complete line of electric vehicles, both pleasure and commercial, were on display.

The electrical association represented and occupying exhibit spaces were the following: Maine Electrical Association, New Hampshire Section of the N. E. L. A.; Vermont Electrical Association, Electric Vehicle Club of Boston, and the Electric Development Association of Boston.

The central station companies represented were: Ayer Electric Light Company, Ayer, Mass.; Adams Gas Light Company, Adams, Mass.; Cambridge Electric Light Company, Cambridge, Mass.; Clinton Gas Light Company, Clinton, Mass.; Daytona Public Service Company, Daytona, Fla.; Edison Electric Illuminating Company of Brockton, Brockton, Mass.; Harvard Gas & Electric Company, Harvard, Mass.; Lowell Electric Light Corporation, Lowell, Mass.; Lynn Gas & Electric Company, Lynn, Mass.; Leominster Electric Light & Power Company, Leominster, Mass.; Malden Electric Company, Malden, Mass.; Mill River Electric Light Company, Williamsburg, Mass.; Milford Electric Light & Power Company, Milford, Mass.; Narragansett Electric Lighting Company, Providence, R. I.; North Adams Gas Light Company, North Adams, Mass.; Northampton Electric Lighting Company, Northampton, Mass.; Spencer Gas Company, Spencer, Mass.; Stamford Light, Heat & Power Company, Stamford, Vt.; Turners Falls Company, Turners Falls, Mass.; United Electric Light Company, Springfield, Mass.; Worcester Electric Light Company, Worcester, Mass.; Williamstown Gas Company, Williamstown, Mass.

The following companies displayed electrical apparatus in tastily decorated booths: Alberger Pump & Condenser Co., of New York; American Brass Co. and Coe Brass Branch, of Ansonia, Conn.; American Electrical Tool Co., of West Newton, Mass.; American Insulator & Mica Co., of Keene, N. H; American Sign Company, of New England; American Storage Battery Co., of Cambridge; American Wood Working Co., Albert & J. M. Anderson Mfg. Co., of Boston; Anderson Electric Co., of Detroit; Ashton Valve Co., of Boston; Atlantic Avenue Electric Garage, Atlantic Vehicle Co., of Newark; Auto-Foto Co., of New York; Automatic Transportation Co., of Buffalo, N. Y.; S. R. Bailey & Co., Inc., of Amesbury, Mass.; Baker Motor Vehicle Co., of Boston; Berger Mfg. Co., of Boston; Betts & Betts, of New York; Blake & Knowles Steam Pump Works, of E. Cambridge, Mass.; Deane Steam Pump Works, of Holyoke, Mass.; Boston Insulated Wire & Cable Co., of Dorchester, Mass.; Buffalo Electric Vehicle Co., of Buffalo, N. Y.; A. S. Campbell Co., of Boston; Campbell Electric Co., of Lynn, Mass.; Century Electric Car Co., of Detroit, Mich.; W. H. Colgan Co., of West Newton, Mass.; S. B. Condit, Jr. & Co., of Boston, Mass.; Conduit Electric Mfg. Co., of Boston; Copeman Electric Stove Co., of Flint, Mich.; Clark & Mills Electric Co., of Boston; Cryptofil Chain Co., of Boston; Deaborn Drug & Chemical Works, of Chicago; Dennen & Hall, of Boston; Ward Drouet & Foster, Inc., of Boston; John Dugdill & Co., of Failsworth, Manchester, England; Duren & Kendall, of Boston; Duntley Products Co., of Erie, Pa.; Economical Electric Lamp Co., of New York City; Edison Storage Battery Co., of Orange, N. J.; Thomas A. Edison, Inc., of Orange, N. J.; Edison Electric Illuminating Co., of Boston; Electric Blower Co., of Boston; Electric Speedometer Co, of Boston; Electric Storage Battery Co., of Philadelphia; Electrical Testing Laboratories, of New York; Engineering Department of the National Electric Lamp Association, of Cleveland, Ohio; Engineering School of Tufts College; L. Erikson Electric Co., of Boston; Fancleve Specialty Co., of Jamaica Plains, Mass.; Federal Sign System (Electric), of Chicago and New York; Flanders Mfg. Co., of Pontiac, Mich.; Flexlume Sign Co., of Buffalo; General Electric Co., of Schenectady, N. Y.; General Motors Truck Co., of Pontiac, Mich.; General Vehicle Co., of Long Island City, N. Y.; Gould Storage Battery Co., of New York; Goulds Mfg. Co., of Seneca Falls, N. Y.; Gray & Fiske, of Boston; Jos. E. Green & Co., of Boston; F. S. Hardy & Co., of Boston; Haskins Glass Co., of Wheeling, W. Va.; Hawley School of Engineering; Hill, Clarke & Co., of Boston; Holzer-Cabot Electric Co., of Brookline; H. W. Johns Manville Co., of New York; Kinetic Engineering Co., of Philadelphia; Kinney Mfg. Co., of Boston; C. S. Knowles, of Boston; Lansden Electric Vehicle Co., of Boston; Edwin C. Lewis, Inc., of Boston; Fred T. Ley & Co., Inc., of Springfield, Mass., Laudin Electric & Machine Co., of Boston; Donald N. McDonald, of

Boston; Massachusetts Institute of Technology; McKenney & Waterbury Co., of Boston; Metropolitan Engineering Co., of Brooklyn; John J. Meyer, of Boston; Minerallac Electric Co., of Chicago; Nelite Works of the General Electric Co.; New England Telephone & Telegraph Co., of Boston; Old Colony Trust Co., Otis Elevator Co., of New York; H. T. Paiste Co., of Philadelphia; J. H. Parker, of Boston; Pettingell-Andrews Co., of Boston; Frank N. Phelps, of Boston; Philadelphia Storage Battery Co., of Philadelphia; H. S. Potter, of Boston; Samuel L. Prentice, of Boston; Pyrene Co., of New England; Rauch & Lang Carriage Co., of Cleveland; Frank Ridlon Co., of Boston; Robins Conveying Belt Co., of New York; Simplex Electric Heating Co., of Cambridge, Mass.; Stone & Webster Co., of Boston; Stuart-Howland Co., of Boston; Studebaker Corporation, of South Bend, Ind.; Toledo Electric Welder Co., of Cincinnati; The Underhill Co., of Boston; Ohio Electric Car Co., of Toledo, Ohio; United Electric Apparatus Co., of Boston; Wagner Electric Mfg. Co., of St. Louis, Mo.; Walker Vehicle Co., of Chicago; Waterbury Co., of New York; Western Electric Co., of Chicago; Westinghouse Electric & Mfg. Co., and Westinghouse Lamp Co; Wetmore-Savage Co., of Boston; Wheeler Reflector Co., of Boston.

THE NEW YORK ELECTRICAL EXPOSITION.

The Electrical Exposition held at New York City is located for the second time in the New Grand Central Palace on Lexington Avenue. Here three floors are given over to exhibits where electrical apparatus is shown and explained, inculding both large and small devices and those of commonplace and complicated design. The exposition was opened with a luncheon to Thomas A. Edison on the afternoon of October 9th, given by the New York Edison Co. This event commemorated the completion of 30 years of central station service, and among the guests were the most prominent and influential in electrical fields.

As was the case at the Boston Electrical Show, central stations around New York City took part in the New York exposition. The Union Electric Light and Power Co., displayed lighting systems for the home, store and factory. The New York and Queens Electric Light & Power Co. showed through a stereopticon the growth and attractiveness of the Queensborough. The Edison Electric Illuminating Co., of Brooklyn, likewise displayed the advantages of Brooklyn from a manufacturing standpoint. The Westchester Lighting Co. displayed in its booth photographs of electrical installations around New Rochelle, Mount Vernon, and other cities near New York. An important series of exhibits were displayed by the New York Edison Co., showing its history and growth during the past 30 years. The old types of generators and models of the modern Waterside station were compared. Charts and other data showed the progress of electrical development in New York City.

A complete report of this exposition will appear in the next issue of Southern Electrician.

The Sons of Jove Convention.

The Rejuvenated Sons of Jove held its annual convention at Pittsburg October 14th, 15th and 16th. Considerable preparation had been made for this convention by Pittsburg Jovians and the event was pronounced the most successful and largest attended meeting of the Jovian Order, as over 700 members were registered. Monday morning was given over to registration with a brief session held at 2 o'clock in the afternoon. At this meeting the convention was formally opened and the visiting Jovians welcomed by W. H. Stephenson, president of the Chamber of Commerce of Pittsburg. A. A. Gray, of Chicago, responded on behalf of the Jovians. The reports read showed the order to be of a growing and flourishing condition.

On Tuesday regular business sessions were held and trips made to Westinghouse Electric & Manufacturing Co., and to the Carnegie Steel Mills in the afternoon. During the evening a large parade took place, the interesting features of which were the subject of attractive headlines in Pittsburg papers. After the parade a rejuvenation and joviation was held and 117 candidates taken into the order.

At the business session, held on Wednesday morning, the election of the Eleventh Jupiter took place as well as the other officers of the Eleventh Jovian Congress. Before the election considerable activity had been displayed on behalf of two candidates, W. M. Deming, of Schenectady, and F. E. Watts, of New York City. Before the voting was complete Mr. Deming moved that Mr. Watts' election be made unanimous. The following is the complete Congress as chosen for 1913:

JUPITER, Frank E. Watts, sales manager, Sunbeam Incandescent Lamp Co., New York City; MARS, W. D. Shaler, secretary Doubleday Hill Electric Co., Pittsburg, Pa.; NEPTUNE, L. M. Cargo, manager of the Westinghouse Electric & Manufacturing Co., Denver, Colo.; PLUTO, A. W. Woodville, sales engineer, Westinghouse Electric & Manufacturing Co., Seattle, Wash.; HERCULES, H. A. Hart, Hartford, Conn.; APOLLO, L. S. Montgomery, Southern sales manager, National Metal Molding Co., Atlanta, Ga.; AVRENIM, W. H. Vilett, manager Minneapolis Electric Motor Co., Minneapolis, Minn.; MERCURY, Ell. C. Bennett, editor of Electric & St. Louis Publishing Co., St. Louis, Mo.; VULCAN, Chas. L. Martin, manager Columbia Incandescent Lamp Co., Dallas, Texas.

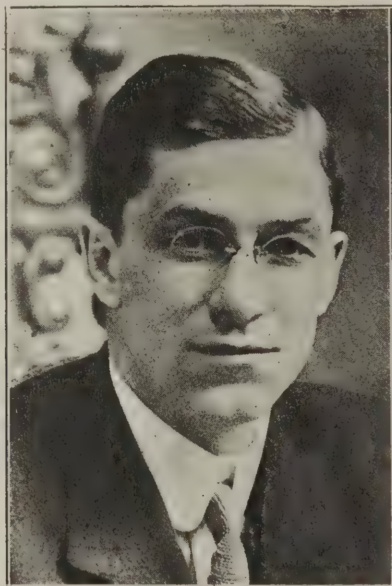
The convention closed with a banquet on Wednesday evening attended by some 500 members and guests, Speeches were made by Eleventh Jupiter Watts, W. M. Deming, R. L. Jaynes, Tenth Past Jupiter; Hon. M. Clyde Kelly, of Braddock; Past Jupiter W. E. Robertson, of Buffalo; J. Robert Crouse, Seventh Past Jupiter, of Cleveland; O. C. Turner, Eighth Past Jupiter, of Birmingham, Ala., S. A. Hobson, St. Louis, Mo., and other prominent Jovians.

The report of Tenth Mercury E. C. Bennett is an indication of the remarkable progress the order has recently made. It showed that during the past year 3,466 electrical men have been admitted to the Sons of Jove, making the total membership, with three rejuvenations yet to come, 8,336. This increase in membership is greater than that made in the previous twelve years, and has been due to a general enthusiasm in the work of the order distributed throughout all sections of the United States.

Frank E. Watts, Eleventh Jupiter.

Mr. Frank E. Watts, chosen Eleventh Jupiter at the Pittsburg convention, was born in Delaware county, Ohio, in September, 1878. He was educated in the schools of Delaware county, Ohio, and the Ohio Wesleyan University, Delaware, Ohio, and the Ohio Northern University, Ada, Ohio, and taught in the public schools of his home county for a number of years. In May, 1904, he gave up teaching to enter commercial business and his first work in this line was selling the products of the Austin Manufacturing and Western Wheel Scraper Co., of Chicago, Ill. On August 1, 1907, he resigned this position to enter into the

incandescent lamp business in the capacity of salesman for the Colonial Electric Co., Warren, Ohio. On October 1, 1909, Mr. Watts was transferred to New York as manager of the eastern branch of the Sunbeam Lamp Department of the Western Electric Company, which position he now holds.



Frank E. Watts, Eleventh Jupiter.

While acting as statesman in New York City from October 15, 1911, to October 15, 1912, his work for the Jovian order has brought the same results in measure that his efforts in other directions have and his record speaks for itself. He organized the Jovian Lunch Club of New York and boosted it from nothing to an average attendance of 160. Among the 154 candidates he has added to the order are the most prominent electrical men in New York City and the order now stands firmly re-established with some 600 members in the city.

L. S. Montgomery Elected to Jovian Congress.

The Southern Jovian who has been honored by election to the Tenth Congress is no new factor in Southern Jovianism. He has served two years as a statesman for Georgia and has to his credit several decidedly successful rejuvenations, which have given him a reputation for being able to advance the interests of the order among the promoters of Southern electrical interests. We refer to L. S. Montgomery, southern sales manager of the National Metal Molding Company, of Atlanta, Ga.

Mr. Montgomery is decidedly a progressive in his ideas and dealings relative to electrical matters and is an earnest worker for the betterment of all interests in all electrical fields. Through his experience he is familiar with the needs of these interests and it can be expected that his administration on the eleventh Jovian Congress will be a continuation of his construction work of the past and bring about as complete a realization as possible of "Altogether All the Time for Everything Electrical."

Although one of the youngest in years, Mr. Montgomery is one of the pioneer electrical men of the Southeastern territory and at the present time is probably the youngest man holding a responsible executive position. His first entrance into electrical affairs dates back to his early teens when his ambition turned to bell wiring and other amateur electrical work. Later he secured a position as electrical cranesman with the Alabama Steel & Wire Company in their new plant at Gadsden, Alabama, in which capacity he served for a year, during which time he operated various types of cranes, charging cars and other electrical apparatus used in the manufacture of steel and steel products.

In the first part of 1905 Mr. Montgomery became connected with James Clark, Jr. Electric Company, Louisville, Ky., manufacturers of electrical apparatus and jobbers of electrical supplies, for whom he traveled in a sales capacity for more than a year, leaving them to acquire a more practical knowledge of electrical installations for which purpose he accepted a position with the construction department of the Westinghouse Electric & Manufacturing Company to assist in the installation of the Gulfport & Mississippi Coast Traction System, from Gulfport to Pass Christian and Biloxi, Miss. Subsequent to his connection with the Westinghouse Company, Mr. Montgomery was connected with the Interstate Electric Company of New Orleans, for whom he traveled in the Southern states and later he accepted the position of contract agent for the Mobile Electric Company, at Mobile, Alabama. Here he made such an enviable record in a most successful electric sign and current consuming device campaign as to form the basis of a paper which he read at an early meeting of the N. E. L. A. at Washington, D. C. When the Western Electric Company opened in Atlanta their first Southern branch, Mr. Montgomery became associated with them and was the first salesman connected with the Atlanta branch. Leaving the Western Electric Company to accept a position on the general staff of the Federal Electric Company at Chicago, where he put in a year of transcontinental work, he returned to Atlanta in 1909 to accept a position as sales agent for the Electrical Products Co., of New York, which at that time controlled the sales of the National Metal Molding Company in the Southeast. The results of his work for the Electrical Products Company led to closer relations with the National Metal Molding Company and in the latter part of 1910 Mr. Montgomery was appointed southern sales manager for this firm, which position he now holds.

Mr. L. S. Montgomery, Southern Sales Manager, National Metal Molding Co., Atlanta, Ga.

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Advertising and Display as Aids to Business Getting.

While it is recognized that direct personal solicitation is ultimately the most effective means of securing new business for the central station, it is not always found the most efficient when used alone. In fact the best results in disposing of any product can only be secured by a thorough study of the conditions, and usually this will be found to require a combination of methods. Sometimes advertising alone, sometimes advertising and display, and sometimes advertising and solicitation, will be found to give the best results.

It is found that some of the widely known commodities can be marketed through advertising alone. In these cases the appeal is so strong and so frequently repeated that the mental impression becomes sufficient to cause action. In selling electric service, however, this is rarely the case. Advertising alone can produce but a fraction of the results to be ultimately obtained and since electric service attains its highest efficiency only with the greatest possible saturation of a territory, it is highly desirable, not only for the interest of the central station but for that of the community that every piece of business that can be secured be added to its lines.

We do not purpose at this time to discuss advertising methods in detail, but to consider in a general way the relative functions of advertising, display and personal solicitation. Let us begin by inquiring, first what classes of people must be reached and, second, in what manner we can best set our proposition before them. Let us consider, for example, the case of a central station just entering upon a campaign for new business. We may divide all non-consumers into two classes, those who are interested, and those who are not. These two classes require radically different treatment, for in the first case, all that it is necessary to do is to call attention to the proposition, offer some slight inducement for immediate action or clear up some small point which may have been deferring decision. In the second case it is necessary to arouse the interest and this takes education, persistent appeal, and generally the overcoming of some prejudice.

Having then these two classes in view, let us see what steps we can take to secure them as customers. There are two general kinds of appeal that can be made, namely, general and special. In the first we include all appeals to the public at large, or the giving out of information which it is desired that everyone should kown, such as the broadcast announcement of some proposition in which every one would be likely to be interested. Under this head should be included general publicity, that is, the getting and keeping of the name and product or services of the company in the public mind. In such appeals those things are emphasized which will be appreciated by the public generally, such as convenience, safety, cleanliness, economy, etc. Obviously, the best way of telling the same story to a great number of people at once is through advertisements. It would cost a large amount to tell these same things to the same number of people by personal interviews and considered simply as a means of producing the general results sought the latter method would be of little if any more value and would take far more time. Furthermore, persistent and judicious advertising will often bring a good many of the first class of non-consumers to the point of decision, and even with the other, or non-interested class, it will aid in arousing interest and pave the way for the solicitor.

In general, however, it is found that the bulk of the business is secured through solicitation. In several of the campaigns coming under our observation, while the proposition was good, the advertising well written and liberal, and while there was every indication that the people read the ads and were interested, yet it took the personal touch of the solicitor to bring the prospects to the point of decision. It may be of interest then to briefly inquire in what way advertising can be best used so as to co-operate with the other efforts that it is desired to make. From a study of the situation, it is quite evident that the advertisements used should be clear, concise, business-like statements of the proposition at hand. They should contain sufficient information to enable the reader to intelligently decide upon merits, without further information. We do not mean that every phase of an elaborate proposition can be explained effectively in a quarter page advertisement, but we do mean to say that whatever the subject that may be discussed, it should be fully explained, not half-explained, so that the solicitor when he calls, will not find the prospective customers laboring under misunderstandings. All high-flown fancies, wordy phrases, and inklings of the facts should be avoided. Do not take up space with personal appeal, but state the proposition simply and stop. In regard to mediums, our comments have been written with newspaper advertising in mind as being the most representative.

Just in the same way that advertising should be planned so as to best assist the solicitor, so should the soliciting be conducted with reference to the advertising that has been and is to be done. It is a waste of energy and a loss of efficiency to have the functions of the two overlap, or fail to meet, for one should begin where the other left off, no sooner or later. The personal interview should be studied so as to proceed with the impression left by the advertisement as a starting point. If a solicitor does no more than we have outlined for effective advertising, he is simply an order-taker, for he does no more than arouse public interest and get what business may be laying around loose and it is hardly worth while to employ him. The successful solicitor must do things that advertising cannot do, or his efforts will not be profitable. He must introduce the personal element into every interview. Salesmen are

expensive and their efforts must not be wasted in generalities, but be reserved for special appeals. It is then clear that the general effect of good advertising, coupled with the personal efforts of good salesmanship, should enable a central station commercial department to get from its territory the last piece of business that is to be had.

There is, however, one further advantage of having personal representatives on the field. Since, to quote W. H. Hodge of the H. M. Byllesby & Co., the public service corporation is the most democratic of all our institutions a direct personal touch with the public in geenral and its customers in particular, is of prime importance, and this can be had, of course, only through men trained for that purpose, men who are more than solicitors, who are more even than salesmen, but men who are in the largest sense representatives of the company, imparting confidence wherever they go in the policy and methods of their employers.

As regards display, it is recognized at once that this, while valuable, is auxiliary. It is not as a rule of much value in reaching non-consumers, unless it be distinctly arranged with reference to current advertising. It is, however, of great value in suggesting to customers other possible uses for the current, and as a convenient place where they may examine and purchase appliances, with assurance of satisfactory operation. It is therefore becoming customary for electric light companies to arrange a show room at their offices so that customers, who come to the office to pay bills, have lamps renewed, or for any other business, will pass through this room and thus be given an opportunity to keep in touch with developments along this line. Demonstrations are of value at certain times, such as during holidays when it is desired to suggest electrical gifts, or at any other time when it may be thought wise to direct attention to some particular appliance, especially one with which the public is unfamiliar. As such they are worthy of notice, but should never be used to the exclusion of other methods. In the December issue holiday new business schemes will be discussed in more detail.

A. G. RAKESTRAW.

Discussion on Commercial Department Organization and Methods in September Issue.

R. B. Mataer, Manager Agricultural Sales, Great Western Power Co., San Francisco, on Salary and Commission.

Commenting on commercial methods as discussed in the September issue, the writer believes that the question of salesmen's remuneration is one that has received the attention of various central stations since 1905, and that while some still adhere to the straight salary, others are loud in praise of the combined salary and commission basis. The salary, to be sufficient to cover all living expenses and the commission, to be based on increased revenue per territory. With a system of commissions based on the increased earnings of that territory over which the salesman has jurisdiction, penalizing as it does the losing of business, every effort is made to retain consumers on the lines, it being evident that they are the ones productive of increased revenue, which costs the company little or nothing outside of the amount paid in commercial effort.

Some central stations that have adopted a plan somewhat similar to the one briefly outlined, have endeavored from time to time to cut down the commission paid to the salesmen, limiting the maximum earning capacity of the man. That this is a fallacy is shown by the inability of the so-called public utility corporations to retain men of high earning capacity in their service for very long periods of time except that some recognition be given in proportion to the services rendered. In determining the commission, it is thought best by some authorities to take the total gross increase over the same period of a year ago and grant a certain percentage for distribution among salesmen in the proportion that the increased earnings of each territory bear to the total gross increase of the combined districts. No doubt such a scheme will result in a rather uniform wage where the territories may be so arranged as to be of equal value, yet the best man may starve on the poorest territory, while the poorer salesman may thrive on that territory which has received the greater amount of educational effort in the past and which is therefore productive of revenue over a considerable period of time without active solicitation.

An equitable compensation for the salesman is a guaranteed wage sufficient to relieve him of all worry incident to the present high cost of living, and a small commission based on additional business from present consumers. New business from new consumers is desired, but additional business from present consumers is subject to a premium by reason of a minimum of connection expenses.

Further in annalizing the net increased revenue of any central station, is it just to consider a certain percentage as a result of natural growth? The population of a city may increase and yet the newly acquired residents may be such as to require a maximum of sales effort. They must be educated that they may be induced to discard the older system of illuminants. The old coal range still occupies a prominent place in the household, and the development along modern lines resulting in the use of current for domestic purposes will only result through a cultivated growth. Those now residents of the city and who are induced to purchase gas or electric consuming devices, while not indebted for their education to the company, may yet have caused the expenditure of a considerable sum of money by some other central station, and their conversion to modern principles of illumination and domesticity are not the result of a natural growth, but of a cultivated growth, entailing considerable expense to the public utility. Therefore, all increase in revenue, either in the industrial or domestic departments of a central station, are the result of the cultivated growth and no reduction should be made for the so-called and unwarranted natural growth.

Mr. W. L. Southwell, Commercial Engineer for the Macon Railway and Light Company, Macon, Ga., Outlines an Interesting House Wiring Campaign.

In what follows the writer has outlined a house wiring campaign conducted by the Macon Railway & Light Company at Macon, Ga. The campaign was conducted chiefly to stimulate residence lighting business among the smaller consumers, and was placed into effect on July 10th, and ran for thirty days. Our offer contemplated the wiring of old houses at cost, allowing the householder twelve months in which to reimburse us.

Contracts for wiring were taken only from property owners or tenants with the owner's personal guarantee. These contracts were taken by the Macon Railway and Light

Company and sub-let to local contractors at prices previously agreed upon between ourselves and the several reputable wiring concerns. Upon completion of the work of wiring, and after our own and the Underwriters' inspection and the householder's approval, the contractor was paid by us in full for the work.

Our campaign contemplated only the installation of fixtures to the amount of $1.50 per outlet, fixtures to be furnished by the contractor, as selected by the customer. The customer paid us 25 per cent of the cost of the wiring upon completion of the work, the balance to be paid in eleven equal installments with the current lighting bill.

By arrangement with the several contractors the following schedule of prices for wiring was placed into effect and strictly adhered to.

COTTAGES—

$1.25 per outlet.
1.25 per snap-switch.
.85 per drop-cord socket and shade.
2.25 per side outlet.

TWO-STORY HOUSES—

First Floor:
$1.75 per outlet.
1.75 per snap-switch.
2.25 per push button switch.
4.50 for two 3-way switches.
Second Floor—Same as cottages.

A charge of 75 cents for running mains to property line was made and a charge of $1.00 to cover entrance switch, etc., where there were less than five outlets. These prices were 25 per cent in excess of the contractors' price to us, so that our profit upon the wiring enabled us to carry on this campaign, and to a very large extent made the campaign pay for itself.

Copies of agreements with the consumers are given here, and also with the contractors, covering each installation.

FIXTURE CONTRACT WITH CONSUMER.

MACON RAILWAY & LIGHT CO.

You are hereby authorized to pay.......................... $......... being the purchase price in full for fixtures purchased by me from them.

I hereby agree to repay the above amount of $............... in the following manner.

25 per cent upon demand, and the balance in eleven equal payments, to be paid each month, with my current lighting bill, until above shall have been paid in full.

(Signed)................................

HOUSE WIRING CONTRACT WITH CONSUMER.

Wiring contract and agreement entered into this..........day of..................1912, by and between the Macon Railway & Light Company, hereinafter called the Company, and.......... ....hereinafter called the Consumer.

Whereas, the Consumer is desirous of having the premises located at............................Street, wired for electric service, as follows:

Front Porch ....
Hall ....
Parlor ....
Dining Room ....
Kitchen ....
Pantry ....
Bed Rooms ....
Back Porch ....
Other Lights ....
....

The Company agrees to furnish above wiring, complete, but without lamps or fixtures, for the sum of...............Dollars, payable upon the following terms and conditions, namely:

$.............upon completion of work; $............. on or before the tenth of each month, with the current lighting bill, until the total amount shall have been paid.

All wiring to be done according to the Southeastern Underwriter's specifications, the same to be inspected and turned over to the Customer in good condition, but the Company shall in no way be liable for any loss, cost or damage arising from any defect in the wiring that may arise thereafter.

No agreement or representation made by any representative of the Company shall be binding upon the Company, unless incorporated in this contract.

In case the Consumer defaults in any of the above payments, then there shall forthwith become due and payable to the Company the total amount still due under this contract.

(Signed)
MACON RAILWAY & LIGHT CO.,
Per...............................

(Signed)................................
(Consumer)

I hereby guarantee payment of all bills, which may become due under above contract.

(Signed)................................
(Property Owner)

In connection with the above campaign, we ran a considerable amount of special advertising. In addition to newspaper advertising we distributed a series of "fliers" and a "wireless telegram," which was delivered by messen-

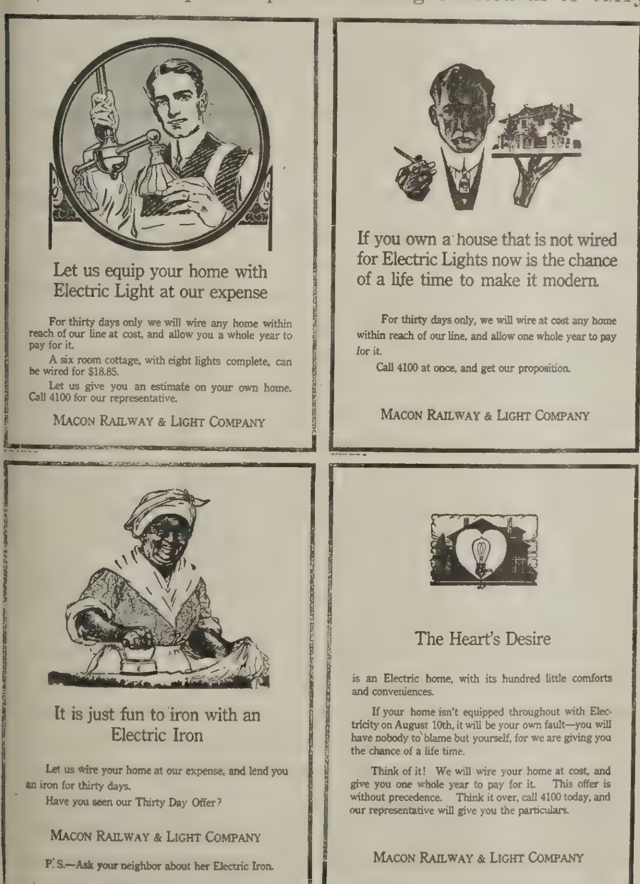


FIG. 1. FOUR FLIERS USED IN MACON CAMPAIGN.

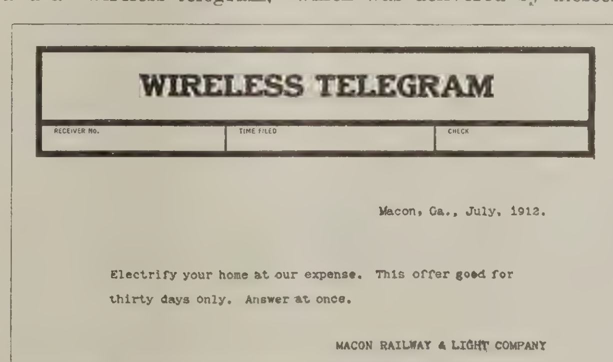


FIG. 2. WIRELESS TELEGRAM USED IN MACON CAMPAIGN.

ger boys and receipted for. This last item proved to be very successful, and stimulated a very considerable amount of interest in our proposition. Copies of these "fliers" and telegrams are shown here.

All business secured was divided equally among the contractors, unless the customer requested that the work be performed by a particular concern, in which event that firm was given the business. This plan resulted in our securing the co-operation of the contractors, who aided us very materially in active soliciting. The campaign resulted in the wiring of one hundred and forty-four whole houses. We contemplate instituting another wiring campaign in the near future, and, profiting by our previous experience, we expect even more satisfactory results.

Cecil Toone, Kent, England, on Industrial Loads for Central Stations.

In attracting industrial load, the central station canvasser must be armed with clear and authentic data concerning actual results already obtained by electrifying works similar to those which he seeks to secure as customers. He must, further, be endowed with infinite patience and a sufficient technical knowledge of the industries concerned to enable him to reply to the arguments devised by owners in favor of existing or proposed steam, gas or oil plants. The great difficulty in making out the case on paper for electric driving is to take proper account of the numerous incidental costs which are very rarely considered by the owner of a steam or gas factory plant. It is here that the value of tabulated records of past canvassing and test, etc., proves so great. Providing a factory owner is disposed to listen to reason, it is generally possible to show a substantial economy in favor of electric driving, (taking into account reduction in supervision costs, avoidance of breakdown, losses and so on). It is obvious that the purchase of electrical energy on a definite basis encourages economy in itself—an economy which can, moreover, be enforced by the use of departmental meters. Any assistance given by the central station that enables a consumer to reduce his bill proves quite as remunerative as honest trading in any other field.

It is impossible to avoid a multiplicity of power tariffs in a progressive supply area. Indeed, in order that station and consumer may both operate under the most favorable conditions, a special tariff should be designed for each power consumer or at least for each industry of any considerable importance. The goal to be aimed at is high station load factor and this is particularly the case in England, where 20 to 30 per cent load factor is at present a high value for central stations, though the modern industrial sections of such important undertakings as that of Sheffield now reach 30 to 40 per cent and higher load factors. It is quite possible for a single additional power load to reduce materially the over-all costs of production of the central stations (especially if no additional plant need be installed to supply the new demand), and it is possible in special cases, by offering the new load the advantage of the economy it enables, to secure a consumer who would stand out if only offered the hitherto prevailing rates of power supply. By making the suggested concession, the station could still secure the same percentage of profit as on its earlier power loads.

Where 24 hour working is practiced, as in mining and in iron works, etc., it is often beneficial to both parties to supply on a "contract" basis, the prices per horsepower month being determined by the maximum demand, say thrice recurrent during the month. This encourages the consumer to distribute his demand evenly during the 24 hours. In certain continental collieries the manufacturers of the electric pit locos employed arrange to attend and maintain these at a rate per month determined by the duty performed or useful ton-kms. A modification of this scheme is in vogue in some English supply areas, the central station loaning and maintaining motors, etc., and recovering their expenditure by an increase in the energy rate agreed upon.

In the case of isolated plants, the outlay in feeders is a serious consideration, particularly if duplicate mains have to be laid in order to insure continuity of supply. What may be termed "abstract" advantages to the consumer of electric supply are specially great in such cases, and it is only fair to require a guarantee of a suitable minimum annual consumption for a certain number of years to recover the cable charges incurred by the station.

An interesting proposal, seeking to reduce the outlay on cables to isolated loads was recently brought to the writer's notice, by a firm specializing in automatic petrol-electric house lighting plant. It is suggested that quite a small feeder should be run to the outlying load which should be supplied entirely by the central station until the demand reached a value beyond which a petrol-electric set at the works could operate economically. Thereafter the full feeder capacity would be supplied by the central station and the remainder of the demand would be supplied by the generating plant on the spot. It could easily be arranged, by various well known means, that the local generating set be started automatically when a predetermined demand was exceeded and the scheme should certainly prove economical in connection with small outlying loads of poor factor.

Before the present plant extensions at Rotherham were completed, it was found necessary to supply at once a considerable outlying load or sacrifice the consumer to a neighboring electricity undertaking. Pending the installation of a new turbo-unit and the laying of cables to a supply station in the new road area, one of the old Allen sets was removed from the central station, (thus making room for the new plant), and installed in the works to be supplied. The works boilers and boiler staff were utilized and paid for by the central station on a "pounds of steam" basis, and current was sold to the works at practically cost prices. The expedient proved economical and mutually satisfactory and is well worth noting.

There are a number of water mills in this country which experience great difficulty in maintaining operation during the dry summer months and there is a good field for central station activity—not fully exploited in a number of districts—in installing electric motors as summer stand-by plant. The mills thus secure the most economical and reliable stand-by equipment possible and the supply station gains a valuable summer load.

Producer gas plant has not realized the unqualified success which was expected of it in industrial application, but an astonishing case can be made for it—and indeed for town gas engines—on paper and canvassers must be fully

informed as to the importance of incidental charges and the effect of load factor on the economy of gas plant. In cases where a steady long-hour demand is to be supplied it is very difficult to show any direct economy in favor of electric motors and though the convenience and departmental economy, under any conditions, and the overall economy on low load factors, are real advantages obvious to the electrical engineer, it is by no means easy to convince the average manufacturer on these points.

There are numerous large works—among them many textile mills—employing private generating plant which cannot be replaced by central station supply for many years to come, owing to the capital cost of conversion and the high efficiency of the existing plant. The necessity for steam, for other than power generating purposes, has also to be allowed for in many industries. Very large engineering works will always adhere to private generation on account of the economy with which they can produce the large quantities of energy required and on account of the excellent opportunity thus afforded for testing experimental and standard plant.

Some of our large cities, in particular London, offer comparatively unfavorable power supply prospects. High rents and rates, building restrictions and costly labor and raw materials have driven manufacturers to other districts and there is no prospect of the power conditions in such cities ever being materially improved. Apart from railway and tramway supply, which is of quite special nature, large printing works offer a load which is necessarily confined to the town area. This class of demand, though totalling an immense annual energy consumption is not wholly advantageous to the supply station. Duplicate feeders are imperative and the load factor of the whole concern is little improved and may actually be decreased —particularly if many periodicals other than dailies are concerned—by the printing load.

If the supply tariff be properly framed it should be unnecessary to offer any "special inducements" to prospective power consumers. Indeed such inducements are economically impossible if the tariff arranged is really the most favorable the station can offer, but to gratify the consumers' natural zest for a bargain a margin of profit may be left, (particularly when dealing with small consumers), from which to grant "free" wiring, lighting at power rates and other "concessions." In a number of districts lighting consumption up to 20 per cent of the power consumption is allowed to industrial consumers at power rates and has in at least one case proved so substantial a concession that other arrangements have had to be made.

Electric Trucks in Nashville.

The Nashville Railway & Light Company is rapidly replacing its horse-drawn vehicles with electric trucks. The latest addition is an emergency tower wagon, which will do the work of two horse-drawn tower wagons. The Nashville Banner of September 28th published a photograph of the new vehicle in operation and said in part: "This move on the part of the Railway & Light Company is in keeping with the general progressive policy of the company, and in introducing the electric tower wagon for the repair of its overhead system, the company will be better prepared than ever to overcome interruptions to street car service."

Early Fall Business of the Byllesby Properties.

On account of general building and industrial expansion in the cities where Byllesby properties are located, the new business management reports a favorable increase in all business. The following is the reported net connected load gain at the properties in the following cities for the three weeks ending October 11, 1912: Louisville, Nashville, Oklahoma City, Chattanooga, Mobile, Muskogee, Okla., Minneapolis, St. Paul, Tacoma, San Diago, Cal., Stockton, Cal., Sioux Falls, S. D., and Fargo, N. D., Ft. Smith, Ark., Eureka and Richmond, Cal., Pueblo, Colo., Sandpoint, Idaho, Ottewa, La., Fairbault, Manbeto and Stillwater, Minn., Kalispell, Montana, Grand Falls and Winot, N. D., El Reno, Enid and Sapulpa, Okla., Albany, Dallas, Eugne and Marshfield, Oregon.

New customers	2,802
Watts lighting	1,899,877
Horsepower in motors	2,403
22 Signs	2,574—5-watt lamps
Flatirons	448
Toasters	52
House wiring contracts	47

These totals do not by any means represent the complete conected load for the devices sold by supply dealers and others are not counted.

At the time of the above report the Consumers Power Company of Faribault, Minn., and the company at Minneapolis lead the list in new power business contracted for, the former having secured 237 hp. and the latter 530 hp. A large part of the power in each of these cases is taken by large new industrial plants under construction. The total horsepower contracted for during the same period as mentioned above by all Byllesby properties was 2,402.

It is stated that the properties in the South and Southwest are to profit by extensive building operations. Mobile is to have a new industry in the way of an oil reduction plant that will cost $200,000. Further, it is rumored that the General Electric Company is planning to build a new branch manufacturing plant at this point in anticipation of the trade that will result through the opening of the Panama Canal and the increasing business from the Latin-American and Southeastern trade. New plants are coming to Muskogee, Okla. A new plow company has been organized with a capital stock of $200,000, and the Missouri, Oklahoma and Gulf Railroad Company is to locate large new shops there. The largest cotton crop in the history of Oklahoma is being harvested and everything points to very favorable business conditions, all of which reflects favorably toward the continued growth of a public service corporation.

Fashion Week in Oklahoma City.

There has recently been held by the retail trade of Oklahoma City, what is known as fashion week. The opening exhibition was held in the evening, and was one of the strongest stimulants for extra display in windows and special lighting effects were used by many. In view of the fact that not only the opening night, but all others drew a large and interested crowd, it is the opinion of Manager Molinard, of the Oklahoma Gas & Electric Company, that a large percentage of the merchants who have added the extra illumination in their windows will allow it to remain as a permanent installation.

Why not other cities start a fashion week?

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

POLES OF AN INDUCTION MOTOR.

Editor Southern Electrician:

(329). Kindly advise through your question and answer columns how to tell how many poles an induction motor stator has and where the winding of one pole leaves off and the other begins. It is to be understood that no information other than that on the name plate is at hand.

P. S. D.

STARTING A MOTOR FROM THREE POINTS.

Editor Southern Electrician:

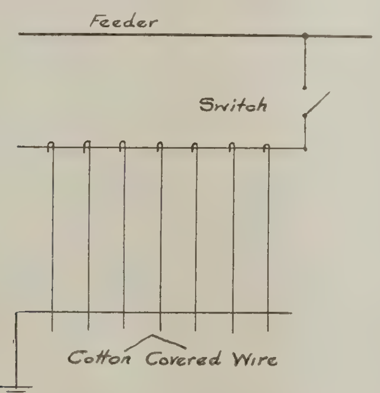
(330). Kindly publish a diagram of circuit wiring so that a 3-phase 3-hp. 220-volt motor can be started and stopped, regardless of how switches may be set, from three different locations. I prefer to use knife switches. The motor must always run in the same direction. There are no automatic devices in the circuit and the diagram should indicate all the apparatus required.

K. W. Hill.

IS THIS AN EFFICIENT LIGHTNING ARRESTER?

Editor Southern Electrician:

(331). While visiting an electric railway power plant recently, I noticed a lightning arrester made up as shown in the diagram herewith. The fuse wire used is a small size of double wrapped cotton insulation hung on the live wire and laying against the ground wire. When the lightning comes in, it breaks down the cotton insulation and current from the machine flows with the result that the fuse wires



LIGHTNING ARRESTER.

are blown up with a flash. The switch is then opened and more fuse wire put in and the switch closed. I would like to get the opinion of readers as to the use of this device and just how much dependence can be placed in it to protect generators from lightning discharges.

R. C. Havenhill.

DESIGN OF SMALL ELECTRIC FURNACE.

Editor Southern Electrician:

(332). I desire to construct a small electric furnace with an air space inside of about one cubic foot. The temperature inside the furnace must be held at 600 degrees F. I desire to know how to compute the size and amount of resistance wire for a heating element that can be used in the furnace so as to heat it by electricity. Consider Nichrome resistance wire and a voltage of 110 D. C. If any other wire is better mention it. Also if the cost of heating the furnace by electricity and gas can be compared please give calculations for gas at 75 cents per 1,000 cubic feet and electricity at 5 cents per kw. hr., furnace in operation eight hours per day.

J. E. B.

RATING OF SWITCHBOARD PANELS.

Editor Southern Electrician:

(333). Kindly advise through Southern Electrician by publishing a formula or other directions, how to determine the ampere ratings of switchboard generator, feeder and induction motor panels for A. C. plants. What instruments are required on the generator and feeder panels? How is ampere capacity of buses for the switchboard computed? Determine the above conditions for a plant having one 100, and one 200 kva. generators, giving sizes of panels and number for street and residence lighting and for factory motor service. The largest A. C. motor is 50-hp. and the motor load is about 150 kw., the lighting load at peak 250 kw. Voltage of generators is 480, at 60 cycles.

G. D. W.

USE OF SHUNT RESISTANCE MULTIGAP LIGHTNING ARRESTERS.

Editor Southern Electrician:

(334). Can the same shunt resistance multigap lightning arrester be used on a grounded *Y* system and on a delta and ungrounded *Y* systems without changes? If not, what changes must be made? Give skeleton diagram, and explain.

H. H. T.

Calculations for Transmission Line. Ans. Ques. No. 306.

Editor Southern Electrician:

In making calculations for a transmission line as described in Question No. 306 in the July issue, it will be easier to follow the calculations to figure all quantities for one wire. Thus the voltage should be the voltage to neutral or line voltage divided by $\sqrt{3}$.

The inductance of a transmission line may be calculated from the formula, $L=[80.5+740 \log (D/r)]\div 10^6$, given by Abbott in Electrical Transmission of Energy. Where L is inductance in Henries for one mile of one wire of a circuit. D is the distance between centers of wires and (r) the radius of the wires. D and (r) must be given in the same units. Substituting in this formula the proper values for the first section of the transmission line referred to, $L=[8.5+740 \log (40/.102)]\div 10^6=.002$ henry per mile of one wire. The inductance of four miles of one wire will be therefore, $4\times.002=.008$ henry.

The capacity of one mile of one wire of a circuit, referred to the neutral, may be calculated from the formula, $C=[.0388/\log(D/r)]$. Where C is in microfarads and D and (r) expressed in any convenient unit as above, care being taken that both are given in the same unit. For the circuit under consideration, $C=[.0388/\log (40/.102)]=.0154$ micro-

farads per mile, or $4 \times .0154 = .0616$ mfs. for four miles of one wire.

The reactance of a circuit or wire is calculated from the inductance as follows: $X = 2\pi f L$ where X is in ohms, f is frequently in cycles per second and L is inductance in henries. Thus the reactance of 4 miles of one wire of the above circuit will be $X = 2\pi \times 60 \times .008 = 3.02$ ohms.

The resistance of 4 miles of No. 4 B & S copper wire from wire tables, assuming a temperature of 75° F., is 5.25 ohms. The impedance then will be the square root of the sum of the squares of the resistance and reactance in ohms. Hence the impedance, $Z = \sqrt{(R^2 + X^2)}. = 6.05$ ohms.

The characteristics of the second and third sections may be calculated as here described with the exception that the inductance of standard conductors is about 3 per cent greater than the value obtained from the formula given above. The following table summarizes these values for the three sections and also for the entire line. Each quantity except impedance, is the sum of the corresponding quantities for the three sections.

QUANTITIES FOR TRANSMISSION LINE CONSIDERED.

	1st Section	2nd Section	3rd Section	Entire Line
Length (miles)	4	6.25	15	25.25
Size of wire	No. 4	No. 1	No. 3	
Spacing (inches)	40	30	30	
Inductance (henry	.008	.0112	.028	.0472
Capacity (microfarad)	.0616	.1047	.248	.414
Resistance (ohms)	5.25	4.09	25.2	34.54
Reactance (ohms)	3.02	4.23	10.56	17.81
Impedance (ohms)	6.05	5.89	27.32	38.86

The charging current of an alternating current circuit is $Ic = (E \times C \times 2\pi f)/(2 \times 10^6)$ for a single phase circuit and for a three phase circuit is $(2/\sqrt{3})$ or 1.155 times the above figure. Hence for the entire line, the changing current will be $Ic = (10{,}000 \times .414 \times 6.28 \times 60 \times 1.155)/(2 \times 10^6) = 0.9$ amperes.

Since the power component of the load current of this circuit is about 43 amperes and the changing current is at right angles in its relation to this, it is evident that it can be neglected in the calculations for drop, etc. In calculating the drop for the first two sections, it will be necessary to consider the end of the second section (10¼ miles from the station) as the receiving end. Assuming that the power factor of the load to this point is 85 per cent, the current per wire will be,

$$I = (\text{H. P.} \times 746)/(E \times \sqrt{3} \times \text{P. F.})$$
$$= (1000 \times 746)/(10{,}000 \times \sqrt{3} \times .85)$$
$$= 50.7 \text{ amperes, of which } .85 \times 50.7 = 43.1$$

amperes as the power component and $\sqrt{(50.7^2 - 42.1^2)} = 26.7$ amperes is the wattless components. The complete formula for the voltage E_s at the station end is,

$$E_s = E_r + I_pR + {}_jI_pX + {}_jI_wR + I_wX + {}_j(I_cR/2) - I_cX/2).$$

In this formula,

E_s = voltage at station end, referred to neutral.

E_r = voltage at receiving end referred to neutral.

I_p = power component of current.

I_w = wattless component of current.

R and X are resistance and reactance respectively and j indicates that the quantities so noted are at right angles to the others and must be added by taking the square root of the sum of their squares. Substituting in the above formula, the constants for the second section of the line and neglecting the changing current, we have,

$E_s = \sqrt{[(5770 + 176.3 + 92.9)^2 + (182.3 + 109.2)^2]} = 6046.2$ volts to neutral at the end of the first section or $6046.2 \times \sqrt{3} = 10470$ volts per phase. Thus the drop in the second section is 470 volts.

The power factor of a line is sometimes referred to as the cosine of the phase difference between generator and receiver voltages, which from the above formula is seen to be $\cos \Theta$ = Power factor = $(E_r + I_p R + I_w X)/E_s$ or $(5770 + 176.3 + 92.9)/6046.2 = 99.8\%$.

A calculation similar to the one just explained for the second section of the line, but using the value obtained there for E_s as the receiver voltage, with the constants of the first section of the line, gives 6356.3 volts as the station or generator voltage (to neutral) or $6356.3 \times \sqrt{3} = 11{,}010$ volts per phase and the drop in the first section of the line is $11{,}010 - 10{,}470 = 540$ volts.

Since the third section of the line is to transmit 500 H. P., maintaining 10,000 volts at the sending end (10¼ miles from the station) it will be necessary to find the voltage at the receiving end as follows:

Let E_r equal the voltage at the receiving end referred to neutral, and I the current per wire. Then assuming 85% power factor, .85 I will be the power component and .527 I the wattless component of the current and,

$$\sqrt{3} \times E_r \times I \times \sqrt{3} \times .85 = 500 \times 746$$
$$= 373000$$
$$E_r = 146270/I$$

Also since 5770 is the voltage, to neutral at the 10¼ mile point, substituting in the above formula for voltage at the receiving end, the constants of the third section we have,

$$5770 = E_r + 25.2\, I_p + {}_j\, 10.56\, I_w + {}_j\, 25.2\, I_w + 10.56\, I_p$$

Then since $I_p = .85\, I$ anl $I_w = .527\, I$

$$5770 = E_r + 25.2 \times .85I + {}_j\, 10.56 \times 527I + {}_j\, 25.2 \times .527I + 10.56 \times .85I.$$

$$5770 = E_r + 27I + {}_j\, 22.3I$$
$$= \sqrt{[(E_r + 27I)^2 + (22.3I)^2]}$$

It is evident that the substitution of (146270/I) for E_r in this formula will result in a very complicated expression. It may be solved approximately, however, remembering that the first expression under the radical is numerically slightly les sthan the left hand member of the equation. By "trial and error" we find that $E_r + 27I = 5735$ or $(146270/I) + 27\,I = 5735$.

The solution of this equation gives I equal to 29.7 amperes from which $E_r = 4930$ volts and the line voltage at the receiving end $4930 \times \sqrt{3} = 8540$ volts. We have seen above that the generator voltage when transmitting 1000 hp to the end of the second section is 11,010 volts. Hence the drop over the entire line is $11010 - 8540 = 2470$ volts.

The power delivered to the third section to transmit 500 hp to the 25¼ mile station is $29.7 \times 10{,}000 \times 1.732 = 514.4$ kw apparent or at 85% power factor 437.3 kw actual. Thus the power lost in the third section is $437.3 - (500 \times .746) = 64.3$ kw, and the efficiency of transmission $373/437.3 = 85.3\%$. The power available for sale or use at the 10¼ mile station will be $(1{,}000 \times .746) - 437.3 = 308.7$ kw. The power delivered to the line by the generat-

ing station is $11,010 \times 50.7 \times .85 \times 1.732 = 821.3$ kw, so that the efficiency of transmission for the entire line is $(308.7 + 373)/821.3 = 83\%$. C. S. STOUFFER.

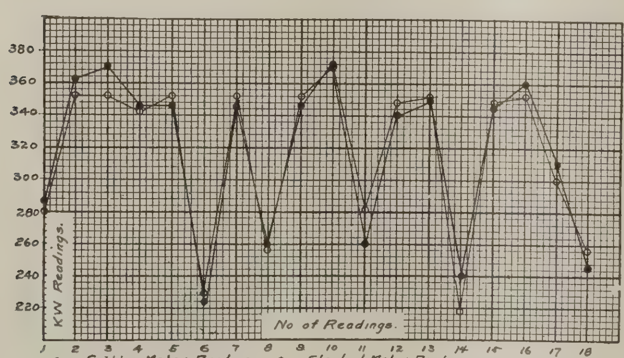
Part 2 of Question on Calculations for Transmission Lines. Question No. 306.

Editor Southern Electrician:

In answer to the second part of question 306 in the July issue, I would say that power factor correction by synchronous condenser would not in general be advisable unless the power factor goes lower than 80 per cent. To determine its advisability in this particular case, it would be necessary to know the local conditions more in detail than given by Mr. King. If the generators, line and transformers are loaded beyond their rated current capacity by the lagging current, but are not overloaded by the power component of the load, a synchronous condenser properly placed will improve matters both as regards heating of apparatus and voltage regulation.

The size of a synchronous condenser necessary for any system cannot be determined without knowing the load in kw as well as the power factor of the load. The article by Mr. J. J. McIntosh on pages 347 to 350 of the August issue of SOUTHERN ELECTRICIAN gives much information on the use of synchronous condensers, the method of determining size being given in column one of page 349.

In this connection it may be well to state that if any additional load is to be taken on, it might be possible to carry this load on a synchronous motor. It is always advisable to use mechanical power from a synchronous motor in preference to running it light for power factor correction only, if conditions are such that a synchronous motor will operate satisfactorily. In this practice there is less money tied up in apparatus and the running losses are a minimum. A synchronous motor would probably hang on, that is, would not drop out of step, with the change in frequency mentioned, but a uniform power factor correction could only be obtained with this varying load by means of a Tirrill regulator installed for this purpose at the motor.



COMPARISON OF GRAPHIC AND STANDARD METER READINGS.

The accompanying curve is plotted according to the data given under part 3, of this question. It is quite impossible to give any reliable explanation for all the variations in the curves shown further than to say that due to the friction and inertia of moving parts, the reading of a graphic meter may be higher or lower than a standard meter on fluctuating loads. This applies particularly to any graphic meter in which the moving system is driven directly by the supply current.

Natural Frequency of a Transmission Line. Ans. Ques. No. 319.

Editor Southern Electrician:

Every transmission line has inductance and capacity, as well as resistance, the value of these quantities depending on the length of the line and the size and spacing of conductors. Such a circuit can store energy in two ways, i. e., in the magnetic field of the inductance and as a charged condenser. The inductance and capacity are in series in a transmission line, and if an E. M. F. is applied to it the line will receive energy which will oscillate back and forth between the capacity and the inductance until it is consumed as I^2R loss in the resistance. The number of these oscillations per second is the natural frequency of the line. Steinmetz has shown that for a transmission line the natural frequency may be expressed by the equation, $f = \frac{1}{4} \sqrt{LC}$. Where $f =$ the natural frequency and L and C the inductance and capacity respectively of the line. It has also been shown (Ferguson's Elements of Electrical Transmission) that if l represents the length of the line then $f = 47{,}00/l$. From this it appears that the natural frequency is practically independent of everything except the length of the line.

The above expression may also be derived by the following simple method, which is based on the fact that electricity travels with approximately the velocity of light. Since an impulse travels twice the length of the line between two impulses of opposite directions or a half cycle, it will travel four times the length of the line in a complete cycle. Therefore, if we divide the velocity by four times the length of the line it will give the number of oscillations per second or the frequency. Thus, $f = 188{,}000/4l = 47{,}000/l$.

The natural frequency of the line should not be the same as the transmission frequency, for if it is and the capacity and inductance are equal so as to give the most favorable condition of resonance, there will be produced an excessively high voltage, which will break down the insulation of the line. These oscillation voltages may easily rise to eight or ten times the impressed voltage of the line. Not only must we avoid having the transmission frequency equal to the natural frequency of the line, but we must see that its higher harmonics do not correspond to the natural frequency, for they will produce the same effects.

The third harmonic can be eliminated by the use of a three-phase generator and delta connections in the transformers, but the fifth and seventh harmonics must be taken into account. For example, if we have a 150-mile transmission line its natural frequency is: $f = 47{,}000/150 = 316$ cycles per second. For 60-cycle transmission the fifth harmonic is $5 \times 60 = 300$ cycles per second, which is dangerously near the natural frequency of the line. If 25 cycles is chosen for the transmission the fifth harmonic is $5 \times 25 = 125$ and the seventh harmonic is $7 \times 25 = 175$. This is safe and 25-cycle transmission should be used.

F. E. VOLK.

Series Arc vs. Incandescent Lighting. Ans. Ques. No. 320.

Editor Southern Electrician:

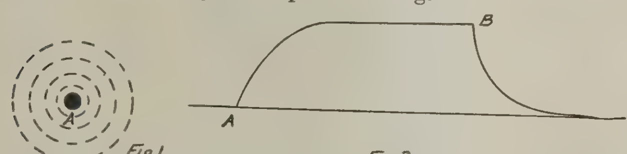
Series carbon arc lamps, series flaming arcs, and series incandescents can all be used, indiscriminately on a 6.6 ampere series circuit with regulating transformer, and by the addition of a mercury arc rectifier the 6.6 amp. luminous arc or magnetite lamp can be used on the same circuit. As

regards the direct comparison of the carbon arcs and the series tungsten, the former takes 425 watts and gives about 144 to 160 spherical candle-power while the latter can be had in several sizes to be used as required. For instance, large lamps could be used on the business corners and small lamps used for middle points of blocks in residence sections as is often done. These lamps can be secured in the following sizes: 25 (spherical) cp, taking 38 watts; 47 cp with 71 watts; 78 cp with 118 watts; 156 cp with 236 watts and 254 cp with 413 watts. The last named lamp would take about as much energy as the arc lamps now in use but would give 70% more light. If it is desired to take the "same light for less money" plan you can take the next smaller size and save nearly 45% of the current cost. Any or all of the arc lamps could be replaced by the series tungstens without any change in the system whatever.

Operation of a Discharge Rheostat. Ans. Ques. No. 323.

The consideration of question No. 323 involves a principle common to all electrical circuits carrying current. Any wire such as *A* in Fig. 1, is surrounded by a magnetic field as indicated by the dotted lines. When the current flow ceases, this magnetic field collapses, the lines of force cutting the conductor, and when this happens we have the same phenomenon occurring as in any other case where a conductor is cut by a magnetic field, that is, we have an induced electro-motive-force, which is called the inductive e. m. f.

This e. m. f. is always in an opposite direction to that causing the current flow, and therefore we find a tendency of any electrical current to persist with the same value which it has. That is, with no current flowing in a wire there is a momentary resistance offered to the setting up of a current, and the same thing is true when a circuit is opened, the current tending to keep on flowing.



Operating Principles of Discharge Rheostat.

If therefore we close any electric circuit, the current does not reach its full value until after an instant of time, the rate of increase depending on the inductance of the circuit. In Fig. 2, *A* represents the point of closing the circuit and *B* the point of opening. In a circuit of straight wire, this effect is not noticeable, but when we have a large amount of inductance, the inductive emf is comparatively large, consequently when the circuit is closed it takes a perceptible time for the field to build up, and when it is opened we get a heavy spark at the switch blades.

The effect of the connections as shown in question No. 323, is to short circuit the field coil with a non-inductive resistance for just an instance as the switch is opened. This gives a chance for the inductive emf to dissipate its energy through this resistance and consequently does not strain the insulation of the field coil.

A. G. Rakestraw.

The Discharge Rheostat. Ans. Ques. No. 323.

Editor Southern Electrician:

In answer to question 323 in the October issue, I offer the following: In the drawing shown with the question, it will be seen that the discharge grid, when the field switch is opened, is thrown as a shunt across the field leads before the circuit is completely opened. The reason for this is found in the fact that if the field of the generator were opened without this means a high current discharge would take place at the switch which would not only be destructive to it but would probably burn out the field coils. The resistance of 180 ohms for the field of a 300 kw generator at 500 volts is about right. For a larger or smaller machine the discharge grid would be larger or smaller in proportion to the size and voltage of the machine.

E. D. Dumas.

Trouble on Telephone Line. Ans. to Ques. No. 325.

Editor Southern Electrician:

The humming noise on the long distance line mentioned by T. C. M. is probably due to a greater difference of potential between the two sides of the circuit than the phones are built to operate on. If the transposition is correct, the trouble is probably the result of a ground, or partial ground, on one side of the circuit causing thereby a potential difference between the two sides of the circuit sufficient to force enough current through the telephones to cause the humming noise, which noise is characteristic of the frequency of the high tension circuit. Removing the ground will overcome this. If this condition were severe enough, as it easily might be, enough current would flow through the telephones to cause the bells to ring.

That one telephone is quiet might indicate that it has different electrical or mechanical characteristics than the others; for instance, a higher resistance in the receiver magnet winding, or a larger gap between the diaphragm and the end of the magnet.

The party line probably has also a partial ground which ordinarily is not noticeable on account of the relatively low induction of the 2300 volt line. When, however, the party line is connected to the long distance line the higher pressure on it shows up the ground on the party line, causing all phones concerned to hum.

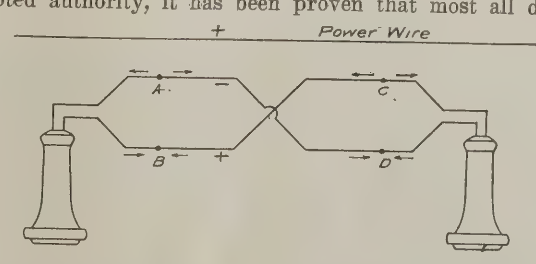
Telephone lightning arresters are a frequent source of such trouble, the gaps between line and ground becoming bridged over by the deposited metal or carbon vaporized during a discharge.

F. S. Lorentz.

Trouble on Telephone Line. Ans. Ques. No. 325.

Editor Southern Electrician:

In regard to T. C. M.'s inquiry No. 325, and trouble on his telephone line, from the investigating data given, I am satisfied there is not enough transpositions in the seventeen mile line, as most companies under such conditions, place them at every second pole, and from eight to ten feet from center. From previous investigations, by a noted authority, it has been proven that most all disturb-



A Receiver Connected Across the Points A B or C D in Diagram Would Be Perfectly Quiet.

ances to which telephone lines are subjected, is due to electrostatic induction. Taking same for granted, by reference to following sketch, you will see why the telephone cut on at a certain point from the end was quiet, as there is always one neutral point on every transposition section and no doubt this point is the one located by the quiet phone.

The reason that the eight party line when connected tends to noise all the telephones, is that it produces an unbalanced circuit, as its relation to the seventeen mile line is altogether different from the phone connected at this point, also the insulation resistance may be low on the eight party line and while not producing any bad effects on the eight party line, would be very noticeable when connected to the seventeen mile line. No doubt the only way the eight party line can be connected with the seventeen mile line with any success under the conditions of connecting, would be with a ring through, and talk through repeating coil, and by using a four pole, single through switch. Both connecting ends of the eight party and seventeen mile line could be left open from repeating coil except when in use. If conditions are such that parties wanted on the eight party or seventeen mile line can be rung before connecting the two lines together, it would be preferable to use only a talk through repeating coil.

E. R. HARTMAN.

Trouble on Telephone Line. Ans. Ques. No. 325

Editor Southern Electrician:

Mr. T. C. M. in your October number under the department "Questions and Answers from Readers," No. 325, refers to a telephone line paralleling a 17,000 volt transmission line, which becomes unduly noisy when switched onto a local system. This might be explained in a number of ways, but without having all the data at hand it seems safe to suggest that poor insulation on the local line with eight bridged telephones is the cause of the noise, since connecting this may be the equivalent of putting a ground on the telephone line of the transmission system.

The trouble may be removed by careful insulation and balancing of the local line, but a better and safer method would be to install a telephone insulating transformer (virtually a repeating coil) at the point of connection between the transmission telephone line and the local telephone line.

JOHN B. TAYLOR.

New Apparatus and Appliances.

Mr. Clifton Whitmore, of Lynchburg, Va., Wins a Watson Motor.

In the September issue of SOUTHERN ELECTRICIAN the copy prepared by The Mechanical Appliance Co., of Milwaukee, of their usual half-page advertisement offered a Watson A. C. ½-hp. motor as a prize to the individual who best answered four questions pertaining to information about the makers of Watson motors, and about the special features of the motors themselves. From the replies received it was made evident that Watson motors were known in the South. All agreed that by concentrating the entire business in the one direction, namely, that of making motors of small and moderate capacities (A. C. to 45-hp. and D. C. to 15-hp.,) a superior motor can be produced. After considering all answers it was decided that Mr. Clifton W. Whitmore, of Lynchburg, Va., had answered all four questions with the highest average. His reply to the questions was as follows:

CLIFTON W. WHITMORE
Electrical Construction
Lynchburg, Va., Sept. 3, 1912.

Sales Manager,
Mechanical Appliance Co.,
Milwaukee, Wis.

Dear Sir:—Please put my hat in the ring on your Free Motor Offer Contest, as advertised in the September number of the SOUTHERN ELECTRICIAN, with the following answers, in rotation:

(1). Mechanical Appliance Co., Milwaukee, Wis.

(2). Watson motors are made in capacities up to 15-hp. direct current—45-hp. alternating current.

(3). The manufacturers of this motor claim that by specializing only on the making of small and medium size motors that they are able to put more time in the perfection of a small motor than that of a large manufacturer whose engineers want to make something larger than their predecessors. This specialization makes the Watson motor one that can be depended upon for reliability and accuracy.

(4). The Watson motors have such a great demand for individual drive because of the fact that they can be

MOTOR WON BY MR. C. W. WHITMORE, LYNCHBURG, VA.

obtained in such a wide variety of types, speeds and sizes. A manufacturer of machinery using the Watson motor as his electric equipment would not have to depend on a number of manufacturers in order to equip his machines for any service.

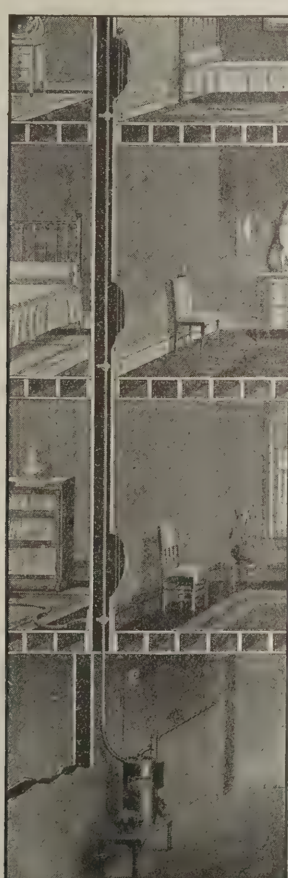
(Signed) Clifton W. Whitmore.

The accompanying illustration supplied by the Mechanical Appliance Company shows the motor won by Mr. Whitmore, just before shipment.

Economy Vacuum Cleaner.

A vacuum cleaner known as the "Economy" Cleaner has recently been placed on the market by the Pittsburg Gage & Supply Company of Pittsburg, in which is used a patented four-blade rotary positive driven pump, the four chambers of which are charged and discharged at each revolution. It is claimed that this insures a positive flow of air, measuring on a mercury gauge from 0 to 20 inches. The pump is oil sealed and runs without wear or heating. Leakage and loss of air is eliminated, while there is a total lack of vibration and objectionable noises.

The separator used in the cleaner is an improved method which assures thorough separation by introducing the dust-laden air to the separating chamber through a tangent connection throwing or swirling the dirt around the space outside o fthe screens and against the wall of the separating tank. The dirt is thus precipitated by gravity to the bottom of the chamber, entirely out of the air passage. The air is drawn to the center through two supported screens, while 95 per cent of the dust is thrown by centrifugal action to the circumference, and falls to the re-capacity below the screens, and the dirt when it



The Economy Vacuum Cleaner Installed.

has accumulated in considerable quantity can then be removed by merely pulling out a hand plate. The small percentage of dust which may remain in the air is entirely removed, as the air only can be drawn through the screen. As an additional precaution, an inner screen is provided so that perfect separation is obtained. This method of continuous elimination of the dirt as above explained is claimed to be the secret of practically 100 per cent constant efficiency of the vacuum in this machine.

The cleaner is operaed by specially wound motors of ample size to operate the cleaners of various capacities; these motors being specially arranged to start with low current.

A New Cutler-Hammer Regulator.

The many uses for a regulator with small motors, electric heating devices, etc., have made a place for a regulating device still smaller than the present small regulator. The accompanying illustration shows a new 5-inch regulator placed on the market by the Cutler-Hammer Mfg. Co., of Milwaukee. Three current adjustments are provided and an "off" point, operation being by means of the small lever extending from the back of the enclosing case. This lever is so arranged that it sets squarely over the contacts

A New 5-Inch Regulator.

which are mounted on the back of the porcelain base. A protecting cement completely covers the resistance material and a black japanned metal case encloses and protects the entire unit. It has a dissipating capacity of 60 watts and can be provided with a total resistance of 1,200 ohms maximum.

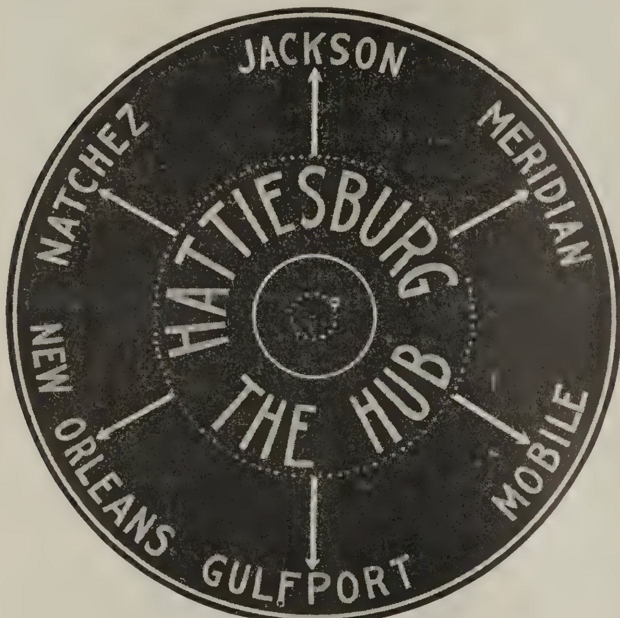
Chapin Pig Tail Carbon Brush.

Patents are pending on a carbon brush manufactured by Chas. E. Chapin Co., Inc., 201 Fulton Street, New York. The brush is known as the Chapin Pig Tail, and is made from high grade carbon adapted to carry heavy loads, the shunt being of copper cable rope. The method of fastening the shunt to the carbon should appeal to the electrician because it is unnecessary to solder the connection. In the Chapin pig tail a conical hole is made in the end of the bolt and when the nut is in place a blow from a pin in a punch press upsets the threads in both the nut and the bolt, so that the nut cannot loosen. This insures full contact during the life of the brush.

An Electric Sign Booms Hattiesburg, Miss.

The accompanying illustration shows an electric sign designed by the Greenwood Advertising Company, of Knoxville, Tenn., which will be installed at Hattiesburg, Miss., so as to operate for the first time with appropriate celebration on Thanksgiving night, November 28. The large circle of the sign is 40 feet in diameter and the name Jackson stands 50 feet above the building upon which the sign is mounted. The supporting structure is built up according to modern truss construction using angle iron.

The letters and outlining of this sign is made up of a new double bent back, non-soldered channel and flanged type of construction, which makes a durable and very strong sign. This type of letter is to be largely used by the Greenwood Advertising Company in new signs now manufactured.



A Slogan Sign at Hattiesburg, Miss.

The full line circles and arrows shown in the illustration show red when lighted and dotted circles green, the different colors presenting a revolving effect in opposite directions. The operation of the sign is as follows: The words, "Hattiesburg the Hub," burn steady, while an arrow and corresponding name of town flashes separately. After the last name appears the whole sign goes out and appears as a whole, then goes out and repeats. The sign contains 1,150 5-watt tungsten lamps, and the letters in the words "Hattiesburg the Hub" are 4 feet high. The sign cost $2,000 and was sold in keen competition, the moving spirits in the purchase and sale being H. S. Stevens of the Hattiesburg Traction Company and Norman B. Hickox, the recently appointed manager of the Greenwood Advertising Company.

The Quad Electric Stove and Fireless Cooker.

The Quad Electric Stove and Fireless Cooker manufactured by the A. L. Sykes Mfg. Co., of Cincinnati, Ohio, is now being made in two sizes, so that it will cook two, three, four or five articles at the same time. The principle change made has been in the base, the heating element being placed out of sight and also out of reach of steam and grease. The element used is a 600-watt Westinghouse iron clad element, which can be furnished to operate on any voltage, namely, 95 to 105, 105 to 115, 115 to 125, 210 to 230, and up to 250. The element used is equipped with a single or with a three-heat switch.

Recent tests on the stove have shown that an internal temperature of 429 degrees can be produced in the larger size, with a current consumption of 30 minutes, and very little loss of heat through the placing of the element to get the maximum efficiency with a minimum of heat loss. The joint between base and cover is a double bevel with the interior opening below the heat zone.

The interior of the cooker is made of drawn seamless aluminum, so that there are no soldered joints in which the heat retaining lining can become vitiated. The exterior is made of 27 gauge blue steel or nickel plated steel, the latter being made by rolling the nickel on the steel and not by plating, thus insuring a longer life than a thin nickel coated cover.

Fig. 1. The No. 1 Quad Electric Stove and Fireless Cooker.

The oven used with the Quad Stove as shown in Fig 2 is semi-ventilated, that is, it has an asbestos lining, and there is an air space between the top and sides. This permits the heat to circulate and allows the moisture produced by the cooking of the food to be carried off. The visible door prevents the necessity of the user opening the door to inspect the cooking and thus prevents a heat loss. The bottom is made interchangeable so that the same oven can be used with the cooker cover. An automatic cut out and time switch can be furnished with the equipment, so that carelessness in leaving the current on unnecessarily can be avoided. Tests have shown that by using the Quad Stove and Fireless Cooker a family of five to seven persons can cook sufficient food for their requirements, with three meals a day, on a current consumption of approximately 27 kw. hours per month.

This device should appeal to central stations as an off-peak current consumer and an excellent means for increasing their day load capacity. It has a further advantage to the user in that no special wiring is required, it being

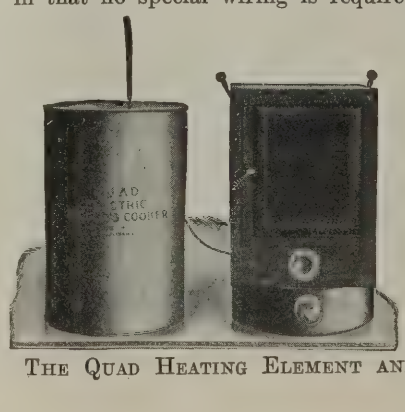
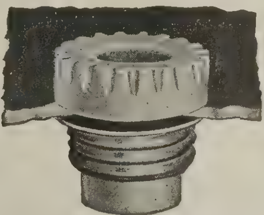


Fig. 2. The Quad Heating Element and Oven.

equipped for connection to a lighting socket. The company manufacturing this stove is prepared to furnish a full campaign for central stations, and where the occasion will warrant and business is sufficient, will properly demonstrate it.

The Thordarson Improved Bushing.

An improved clamp bushing has been placed on the market by the Thordarson Electric Mfg. Co., of 501 South Jefferson street, Chicago, for which is claimed simplicity, time, labor and money saving points. It is made of one piece of vitrified porcelain, equipped with two threaded metal sleeves. One of the sleeves is permanently anchored to the body of the porcelain, while the other holds the bushing while in use. This arrangement, it is claimed, insures a precision of action and a saving of time far in advanceof other bushings, in most of which difficulty is experienced on account of bushings and sleeves not being interchangeable.

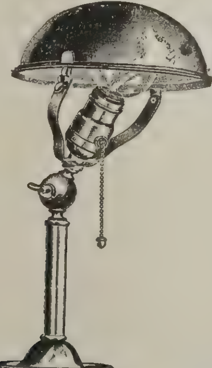


The Thordarson Improved Bushing.

An added advantage of the bushing is said to be that the loose sleeve is reversible and when applied in that fashion holds the bushing squarely in place in walls up to ½ inch in thickness. For motor or transformer work, or where bushings must be screwed into a solid casting or wall the bushing is particularly adaptable. The bushing, in common with their other specialties, is approved by the National Board of Underwriters.

A Portable Adjustable Lamp.

The illustration presented here shows a ball point adjustable lamp manufactured by the Plume & Atwood Mfg. Co., of Waterbury, Conn. This lamp is designed so that both lamp and reflector can be set at any position for table use or can be hung on the wall and used as a side light. It measures 14 inches high over all and the reflector is 7 inches in diameter, with brush brass outside and white enamel inside. The lamp is equipped with pull socket, attachment plug and six feet of silk cord, with necessary wiring ready for use.



A Portable Adjustable Lamp.

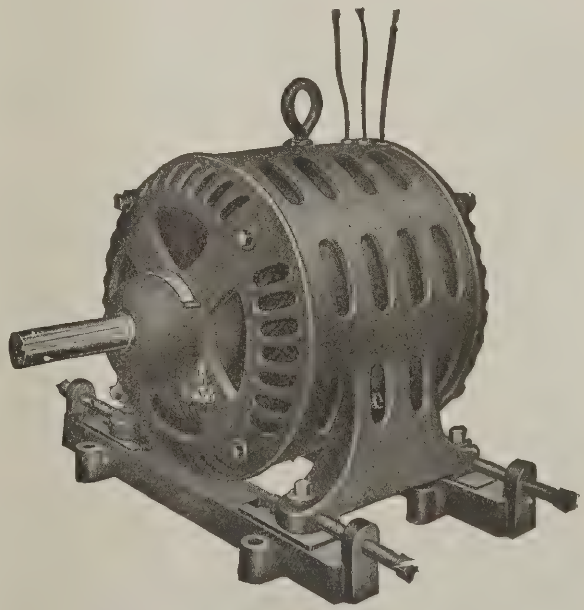
The Cutler-Hammer Receptacles.

The increasing use of household electric heating devices and small motor-driven devices has created a demand for plug receptacles, because it is not always convenient or desirable to feed these devices from the fixture socket. Attachment plug receptacles specially designed have recently been put on the market by The Cutler-Hammer Mfg. Co., of Milwaukee, to fit in with their line of porcelain and composition attachment plugs. The caps for the three styles of receptacles and the attachment plugs are identical so that where the plugs are already in use the receptacle without the cap can be installed unless, of course, a separate cap is desired. White porcelain and black composition caps are furnished same as with the attachment plugs.

Addition to Watson Polyphase Motors.

The Mechanical Appliance Company, of Milwaukee, has recently added to its line of Watson polyphase squirrel cage and slip ring motors, standard sizes up to 45 hp for 110, 220 and 440 volt circuits. As with the original line of D. C. motors it will be the company's policy to concentrate on the building of motors of small and moderate capacities, such as are used in probably ninety per cent of manufacturing and industrial plants. The accompanying illustration shows one type of squirrel cage motor. One feature of note in the construction of this type is the arrangement of the bars between the core and short-circuiting end rings which act as blower vanes. Air is forced through the coils of the motor and the inherently good overload performance of the squirrel cage type of motor is further aided. Semi-enclosed slots and form-wound coils are employed. The coils are protected from the core punchings at the ends by fibre sheets, and after assembling are immersed in an insulating and moisture repellant compound. The bearings, frame, shaft, etc. have been designed along lines proven correct in the Watson D. C. motors.

For applications requiring high speed and direct drive such as for vacuum cleaners, etc., the new 3600 rpm motors are especially built. Every precaution is taken in the design and manufacture to insure a balanced rotor.



The Watson Squirrel Cage A. C. Motor.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

ALABAMA CITY. The Alabama Power Development Co., has been granted a franchise to enter Alabama City. It is understood that a transmission line will be extended from Anniston to Alabama City.

ATTALLA. The Alabama Power Development Co., of Gadsden has taken over the property of the Etowah Light & Power Co., and is planning to raise the dam on Willis Creek about ten feet, so as to increase the output of the plant about 2,000 horsepower.

BIRMINGHAM. The Birmingham Railway, Light & Power Co., will build a sub-station at the North Birmingham line.

DECATUR. Reports state an ornamental street lighting system is being considered for Decatur and New Decatur. It is now planned to connect both cities by the system.

GADSDEN. The Alabama Power Development Co., has prepared plans for the construction of a 10,000 K. W steam plant to be located at Gadsden. The power station will be of concrete and brick, 150 feet by 160 feet, to cost approximately $300,000. Sargent & Lundy, of Chicago, Ill., are consulting engineers.

HUNTSVILLE. The Alabama Interstate Power Co., will make extensive improvement to its power plant and railway equipment. The expenditure will be about $50,000.

MONTGOMERY. The Alabama Interstate Power Company is constructing a dam and power house at Locks 12 on the Coosa River, between Birmingham and Montgomery. The dam and power house sub-structure will be constructed by McArthur Bros., of New York. The dam will be 1,500 feet long and the water turbines installed will operate under a head of 68 feet. Four vertical turbines of the single runner type, each 17,000 horsepower, will be installed and provision made for two units for future installation. The chief engineer is E. A. Yates and located at Montgomery, Ala.

SPEIGNER. Machinery will be installed at the cotton mill at Speigner as soon as the dam in connection with the hydro-electric development is completed. The power house has been completed and will have an output of 160 horsepower.

FLORIDA.

AUBURNDALE. The granting of a franchise is under consideration for the installation of an electric light and ice plant and water works system.

GAINESVILLE. A consulting engineer has been employed by the city council to prepare plans and specifications for a proposed electric light plant. Bonds to the extent of $35,000 have been voted.

JACKSONVILLE. It is understood that the Jacksonville Interurban Railway & Tunnel Co. is planning to construct tunnels under the St. Johns River from Jacksonville to South Jacksonville and to build an electric line from Jacksonville to Pablo Beach.

SANFORD. A small electric light plant will be installed by the Sanford Manufacturing Co.

GEORGIA.

ATLANTA. Bids are open for the electric wiring, steam heating and plumbing of the Fulton County Court House.

ATLANTA. The Findlay Electric Porcelain Co., desires to correspond with chambers of commerce or other parties in a position to make a proposal in regard to establishing a modern porcelain plant. Address care of Southern Electrician.

BOWDON. A bond issue of $8,000 has been voted to build an electric light plant. The mayor, W. C. Beck, can give other information.

COLUMBUS. The Columbus Power Company is planning to erect a transmission line from Columbus to Americus, for the purpose of supplying current for light and power.

DARIEN. The Darien Ice & Light Company has been awarded a contract to light the streets. W. H. Blount will have charge of the plant.

MEIGS. A municipal electric light plant will be installed and cost approximately $21,000.

NORTH CAROLINA.

ASHEVILLE. Hydro-electric plants on the French Broad basin will be constructed by Louis Power and W. S. Becker.

DONALDSONVILLE. Plans are under way for improvement of the municipal electric light plant and water works system. It is understood that gas engines will be substituted for steam engines, now in use.

NEWBERN. Bids are now open for rebuilding and remodeling the electric light plant. F. C. Patterson is city clerk and can give other information.

KENTUCKY.

CORYDON. A resolution has been adopted by the board of aldermen to vote on an issue of bonds for the construction of an electric light plant.

RANDLEMAN. It is understood that the Randleman Power Company desires to purchase a 100 K. W. direct connected generating unit to operate on a 60 cycle, 2,300 volt, three-phase circuit. A four-valve Corliss engine of about 100 horsepower will be purchased, new or second hand.

WILKESBORO. Mr. J. H. Humphries, who owns the Moravian Falls water power, plans to develop it and furnish electricity to Wilkesboro for light and power.

SOUTH CAROLINA.

CHARLESTON. The North Charleston Water & Light Co., has been organized. E. W. Durant, Jr., is president and treasurer.

COLUMBIA. The Parr Shoals Power Company is to build a dam across both the stream and island of the Board River at Parr Shoals to create a pond extending 12 miles up the river, with an area of 2,400 acres. Eight 2,000 K. W. main units will be installed, and a steel tower double circuit transmission line erected through Columbia for transmission of electrical energy at 66,000 volts and 40 cycles.

CONWAY. The Conway Light & Power Company desires a 50 K. W., three-phase 2,300 volt generator. Also a Corliss engine to operate condensing.

GREENVILLE. The River Falls Company has been organized with a capital stock of $60,000 for the purpose of installing power, water and sewer systems. O. K. Maudin, of Greenville, is the attorney for the company.

MANNING. J. A. Newton Johnson, of Florence, S. C., has been engaged to prepare plans and estimates for an electric light and water works system. Prices are desired on electrical machinery and equipment.

SUMTER. L. I. Parrott, president of the Parrott Milling Co., desires prices on a 50 horsepower electric motor.

WHITNEY. The Southern Aluminum Company has awarded contracts to the General Electric Company for electrical equipment to be placed in its power plant at Whitney. It is understood that this equipment will cost about $400,000 and will supply electricity for the extensive aluminum works at that place. The generating equipment is the largest D. C. equipment ever built and consists of seven 5,000 K. W. and two 2,500 K. W., 250 volt alternating current generators with necessary switchboards and other apparatus. Plans call for a second plant, which will be constructed later and be of capacity to develop 35,000 H. P.

TENNESSEE.

ADAMS. The Beech Valley Milling Company is to install a hydro-electric generating plant. S. M. McMurray, of Nashville, Tenn., is the engineer.

CHATTANOOGA. Commissioner A. N. Sloan, of the Department of Streets and Sewers, is considering the installation of a municipal conduit system for electric wiring in Chattanooga.

DRESDEN. It is reported that the Dresden Commercial Club is promoting a movement for an electric light plant and water works system.

JOHNSON CITY. Plans are under way for the installation of an ornamental street lighting system in the business district.

KNOXVILLE. It is understood the Aluminum Company of America, at Pittsburg, Pa., is considering a hydro-electric development at Knoxville.

MANCHESTER. The Stone Fort Power Company has been organized by W. G. Cummings, H. T. Brown, Mrs. S. H. Wooden and John Thumbley. Sites at Big Falls and Little Falls, where hydro-electric power plants are to be constructed, have been leased. The Little Falls plant will be completed in about three months.

SELMA. The Selma Electric Light & Gin Company is being incorporated with a capital stock of $5,000 by C. B. Steadman,

president; F. S. Kendrick, vice president; Albert Gillespie, secretary and treasurer.

TEXAS.

FORT ARTHUR. The lighting system of the Fort Arthur Water Company has been taken over by the Stone & Webster Company, of Boston, Mass. A 100 K. W. turbine is being installed and other improvements will follow. The company will now be known as the Fort Arthur Light & Power Co., and will be capitalized at $600,000.

PERSONALS.

MR. J. McA. DUNCAN has been appointed district manager of the Westinghouse Electric & Mfg. Co. for Pittsburg district in place of Mr. W. F. Fowler, who has resigned to accept a position with the W. S. Kuhn Corporation. The Pittsburg sales office has charge of all the sales for the Pittsburg district and is one of the most important of the offices maintained by the Electric Company. Mr. Duncan has been in the employ of the Westinghouse Electric & Mfg. Co., for about 25 years, and is one of the original group of eight men taken from the Union Switch and Signal Company, then located on Garrison Alley, Pittsburg, to form the Electric Company, which was established at the same place. His first position was in the shipping department, where his ability was soon proved to the satisfaction of his employers, and he was placed in the Correspondence Department, of which he was afterwards placed in charge. In this position he had charge of all railway and lighting apparatus made by the rapidly growing company.

In 1906 he was placed in charge of the price department, and, as head of this division of the company, passed on prices of all appartus manufactured. For a year or two he was located in the New York office on some special work in connection with the costs. Mr. Duncan then returned to East Pittsburgh and was attached to the Manager of Works' office as Director of Costs, and later as Assistant Manager of Works in charge of production and costs. Last spring, when the present revival of industry began, the increased activity resulting from the additional business secured necessitated a division of work, and Mr. Duncan was appointed Director of Works Accounting. He has assumed his new duties with the office in the Union Bank Building, Pittsburgh, Pa.

KERN DODGE, a well-known engineer of Philadelphia, has returned from a year's travel abroad and announces the opening of an office in the Morris Building, Philadelphia, where he will devote himself henceforth to the engineering and financing of public service properties. Mr. Dodge was one of the founders and for many years one of the partners of the well-known engineering firm, Dodge & Day. His new offices are in the suite with the banking firm of William A. Read & Company.

PROF. DUGALD C. JACKSON, head of the department of electrical engineering at the Massachusetts Institute of Technology, has been granted a leave of absence for the purpose of rendering a consulting service to the British Government in connection with the purchase of telephone lines in England by the English Post Office department. Prof. Jackson has already been in consultation with English engineers on the work and has now been called for the final work of appraisal. The work comprises not less than fifteen hundred exchanges, serving half a million subscribers and having a capitalization of not less than sixty million dollars. Prof. Jackson's lectures will be given during his absence by C. A. Adams, professor of electrical engineering at Harvard.

OBITUARY.

MR. ALFRED F. MOORE, widely known wire manufacturer of Philadelphia, died at his home in that city on Sept. 18th. Mr. Moore was in his 59th year at the time of his death, being a native of Philadelphia, and a member of one of the city's oldest and most representative families. The news of his death has come as a sense of deep loss and bereavement to all who had been brought within the sphere of his kindly and helpful influence and personality. The business of which he was the active directing head, located at 3rd and Race Sts., Philadelphia, was established by his grandfather nearly a century ago. Mr. Moore began his business career in 1870, when he entered the employ of the firm of Joseph Moore & Son, composed of his father and brother. Later he was admitted to partnership, the name being changed to Joseph Moore & Sons. In 1878, some time after the decease of the other partners, the name of the concern was changd to, and still remains, Alfred F. Moore.

At the time Mr. Moore became connected with the business, the electrical field was extremely limited and there were probably not over six concerns manufacturing insulated wire of any kind for use with electrical apparatus. The business of the firm at that time consisted largely of the manufacture of wire for bonnets and hats. There was also a considerable trade in cotton and silk covered magnet wire for winding telegraph instruments, medical batteries and some few other types of electric appliances; and they also manufactured a variety of flexible cords for use on these instruments. After the firm name was changed to Alfred F. Moore, there were tremendous strides in electrical progress, and Alfred F. Moore was a pioneer in the manufacture of all kinds of insulated wire and flexible cords for the new application of electricity. The electric light, the telephone, electrometallurgy, wireless telegraphy, electric street railways and all the various modern applications of electric current have become commercial successes since the entrance of Mr. Moore into business, and in all of these Alfred F. Moore has been in the front as a source of supply for the varied and increasing needs in wires, cables and cords.

Mr. Moore has been prominently identified with the activities of the Union League of Philadelphia, having been a member since 1884, and Vice President of the club in 1901. He was also a member of thte Bachelor's Barge Club. The commercial institutions with which he was connected were many. He was at the time of his death a director in the Franklin Fire Insurance Company, the Second and Third Streets Passenger Railway Company, President and Trustee of the Northern Liberties Gas Company and Vice President and Director of the County Fire Insurance Company. He was formerly a member of the Board of Directors of the House of Refuge. He was a director in the National Bank of Northen Liberties, of which his brother, Mr. Joseph Moore, is president.

No change will be made in the firm name, or the general conduct of the business, which will be under the management of Mr. Antoine Bournonville, who has been actively associated with Mr. Moore in the management of the business for thirty-five years. Mr. Moore had gathered around him an able force of assistants and the personnel of the sales force, manufacturing departments and agencies will remain unaltered, the same efficient service being rendered as heretofore.

INDUSTRIAL ITEMS.

THE MOLONEY ELECTRIC COMPANY, St. Louis, Mo., has recently received orders for "High Efficiency" Moloney Transformers from the Columbia Quarry Co., St. Louis. Mo., one 200 K. V. A., 13,200 volts, three phase, Centralia Gas & Electric Co., Centralia, Ills., one 25 K. V. A. one 30 K. V. A., and one 50 K. V. A., 6600 volts, Alta Bert Gold Dredging Co., San Francisco, Cal., three 75 K. V. A., Brush Elec. Co., Galveston, Texas, two 100 K. V. A., Pearson Engineering Corporation, New York, N. Y., one 250 K. V. A., one 50 K. V. A., three phase, East St. Louis & Suburban Ry., three 100 K. V. A. Ft. Dodge, Des Moines & Southern Ry., three 40 K. V. A., 22000 volts, Menominee Range Power & Railway Co., two 200 K. V. A., Cedar Rapids & Iowa City Ry. & Lt. Co., two 125 K. V. A., three 75 K. V. A. and two 37.5 K. V. A., 16,500 volts, Rio de Janeiro Tramway, Lt. & Pwr. Co., two 100 K. V. A., Farmington Lt. & Pwr. Co., one 50 K. V. A., Mexican Lt. & Pwr. Co., Ltd., one 50 K. V. A., Richmond Electric Co., two 80 K. V. A., Kinser Construction Co., St. Louis, Mo., three 400 K. V. A., 13,200 volts and the Wapsipinicon Power Co., one 150 K. V. A., one 75 K. V. A., 13,200 volts, three phase.

MESSRS. WALKER AND KEPLER, a well known electrical contracting firm of Philadelphia, have been appointed agents for the Columbia Incandescent Lamp Works of General Electric Company for Philadelphia and surrounding territory. The large stock and complete distributing organization maintained by Messrs. Walker and Kepler insure maximum efficiency, and promptness in handling orders of all sizes for Columbia lamps.

THE WESTERN ELECTRIC COMPANY announces regular monthly increases in business. July was 3 per cent ahead of the preceding July, August was the same percentage ahead of the same month in the preceding year and September now reports an increase of 4 per cent over September of 1911. The nine months so far reported show a gain of 3 per cent over the same period a year previous, so that it now appears that the company will run close to the early estimate of a gross business for 1912 of about $67,000,000. The Western Electric Company has not felt any of the large expansion that the other electrical companies have had and are experiencing, but is showing a quiet and steady growth over the last year, which seems to be quite in line with all that was expected of the year by the officers of the company. The expectations of the fall are for a showing along the same lines as the year has resulted to date.

It is difficult to explain the reasons why the Western Electric Company has not responded to the boom which the other electric companies are enjoying. One reason, perhaps, is that the corporation last year did not suffer from the decline in activity that the other companies went through, showing a gross business of approximately $63,000,000 for twelve months, which made 1911 the second largest year.

TRADE LITERATURE.

NATIONAL MAZDA STIMULATOR. The October issue of the National Mazda Stimulator is an electric railway number and among many interesting features are found two of particular importance. These are, first an article by C. W. Bender on the development of illumination for electric cars and the results of tests on carbon, tantalum and mazda lamps. Second, a talk by R. E. Campbell on the proper lamp for a circuit in which he reviews the important features which should govern the selection of lamps. The National Mazda Stimulator is a factor in the educational campaign now being conducted by the National Quality Lamp Division of the General Electric Company for better and more economical illumination through use of Mazda lamps.

THE OTTO CYCLE, Vol. 1, Number 5, published by the Otto Gas Engine Works, of Philadelphia, Pa., is a special number describing the Otto horizontal crude oil engine operating on the Diesel principle. On page 14 is found interesting and valuable comparison data on cost of fuel for different types of engines based on full load, 10 hours per day, 300 days per year and for a 50 horsepower engine.

CIRCUIT BREAKERS. The Condit Electrical Mfg. Co., of Boston, Mass., has issued bulletin No. 400 devoted to carbon-break circuit breakers known as types C and K. The type C is made for direct current circuits in plain overload trip only and for both direct and alternating current in plain shunt trip or push-button type. It is intended for industrial use for the protection of motors. The type K circuit breaker is used to protect motors and generators and for all direct current work where it is deemed advisable to have a device which will open the circuit on abnormal or predetermined condtions of a circuit. The bulletin describes in detail these breakers and gives illustrations. These can be obtained from the Southern office of the company at Room 1206 Empire Bldg., Atlanta, Ga., F. V. L. Smith, manager.

BELL RINGERS. Bulletin No. 2, a 32-page book 3 1-4 inches x 6 inches, describing the various types of Viking Bell Ringers, has just been issued by The Viking Electric Co., 150 Chambers St., New York. This should be a very valuable book for engineers, electrical supply dealers and contractors. There are several tables showing actual tests made of more than 140 bell installations, showing the type of Viking Bell Ringer used on each installation, and the results obtained. There are also some very interesting and valuable data with regard to the operation of bell circuits with bell ringers. On page 8, is a special message to contractors.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

Cabinets.

ALLSTEELEQIP COMPANY, Aurora, Ill. Cabinets of standard N. E. Code requirements. Approved Aug. 9, 1912.

A. G. ELECTRIC & MFG. CO., P. O. Box 406, Seattle, Wash. Cabinets of standard requirements. Approved Aug. 9, 1912.

ADAM ELECTRIC CO., FRANK, 904-914 Pine St., St. Louis, Mo. Cabinets of standard requirements. Approved Sept. 25, 1912.

J. P. MFG. CO., Niverville, N. Y., Cabinets of standard requirements. Approved Oct. 2, 1912.

MILWAUKEE VAULT AND ELECTRIC CABINET BOX CO., 521-523 Market St., Milwaukee, Wis. Cabinets of standard requirements. Approved Oct. 2, 1912.

OREGON WELDING & MFG. CO., 305 Glison St., Portland, Ore. Cabinets of standard requirements. Approved Aug. 13, 1912.

POST-GLOVER ELECTRIC CO., Cincinnati, Ohio Cabinets of standard requirements. Approved Sept. 30, 1912.

MURDOCK ELECTRIC MFG. CO., 19 S. Eleventh St., St. Louis, Mo. Cabinets of standard requirements. Approved Oct. 2, 1912.

Conduit, Flexible Steel.

TRENTON ELECTRIC AND CONDUIT CO., Trnton, N. J. Conduits of standard N. E. Code requirements. Approved Sept. 30, 1912.

Conduits, Rigid.

MARK MFG. Co., Chicago, Ill. "Navalite" and Zinkote conduit satisfies N. E. Code. Approved Aug. 30, 1912.

WESTERN CONDUIT CO., 516 Stambaugh Bldg., Youngstown, Ohio. Conduit, "Buckeye" satisfies N. E. Code. Approved Sept. 11, 1912.

Flexible Coid.

GOODRICH COMPANY, B. F., Akron, Ohio. Marking: One red and one black thread parallel in braid with one red thread crossing. Standard N. E. code 1911. Approved Oct. 2, 1912.

LOWELL INSULATED WIRE CO., Lowell, Mass. Marking: Two yellow threads parallel with the wire between rubber insulation and braid. Standard N. E. Code, 1911. Approvêd Aug. 29, 1912.

Panelboards.

A. G. ELECTRIC AND MFG. CO., P. O. Box 406, Seattle, Wash. Two and three-wire panelboards, 125-250 and 250 volts. Approved Aug. 9, 1912.

ALMSTEAD MFG CO., 183-187 N. Waters St., Rochester, N. Y. Two and three-wire panelboards, 125, 125-250 and 250 volts. Approved Sept. 11, 1912.

CARSTARPHEN ELECTRIC CO., Colfax and Broadway, Denver, Colo. Two and three-wire, 125-250 and 250 volts. Approved Sept. 11, 1912.

COMMERCIAL SWITCHBOARD MFG. C., 1858 Arapahoe, St., Denver, Colo. Two-wire 125 and 250 volt and three-wire 125-250 volt with or without main line and branch circuit switches and N. E. Code cartridge enclosed or Edison plug fuse extension in branch circuits. Approved Oct. 2, 1912.

DRENDELL ELECTRICAL AND MFG. CO., 169 Erie St., San Francisco, Cal. Two and three-wire, 125, 125-250 and 250 volts. Approved Oct. 3, 1912.

LANG ELECTRIC CO., J., 423 N. Lincoln St., Chicago, Ill. Two and three-wire 125, 125-250 and 250 volts. Approved Sept. 11, 1912.

NEWGARD AND CO., HENRY, 947 Washington Blvd., Chicago, Ill. Standard N. E. Code requirements. Approved Oct. 2, 1912.

POST-GLOVER ELECTRIC CO., 314-316 W. Fourth St., Cincinnati, Ohio. Two and three-wire, 125, 125-250 and 250 volts. Approved Sept. 11, 1912.

Signs, Electric.

AMERICAN SIGN CO., 219-223 E. Main St., Kalamazoo, Mich. "American" Lens Signs. Sheet metal signs with angle iron frames. Letters outlined with round glass lenses. Illumination by means of lamps mounted in pairs inside of sign. Approved Sept. 26, 1912.

BETTS AND BETTS, INC., 306 W. 53rd St., New York, Betts and Betts sheet metal signs. Approved Sept. 26, 1912.

FRICKER, F., 278 Pearl St., New York. Satisfy standard requirements. Approved Sept. 19, 1912.

GREEWOOD ADVERTISING CO., 511-515 State St., Knoxville, Tenn. Sheet metal closed boxes forming a single letter or a sign casing upon which lamp receptacles are mounted for wiring inside the enclosure. Approved Sept. 26, 1912.

Switch Boxes.

BONNELL MANUFACTURING CO., Cleveland, Ohio. Pressed steel boxes in single units for use with flexible tubing. These boxes have one removable side and suitable fastenings by means of which a gang box of any desired number of units can be obtained. Approved Sept. 27, 1912.

HOUSE ELECTRIC CO., W. D., 1430 Main St., Kansas City, Mo. "W. D." assembled pressed steel boxes for use with flexible tubing. Approved Sept. 21, 1912.

Wires, Rubber Covered.

CRESCENT INSULATED WIRE AND CABLE CO., Trenton, N. J. Marking: Red and blue threads crossing in the braid or red and green threads crossing in the braid. N. E. Code, 1911. Approved Sept. 24, 1912.

ROME WIRE COMPANY, Rome, N. Y. Marking: One yellow and one green thread woven together in braid. N. E. Code, 1911. Approved Aug. 20, 1912.

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CONTENTS.

Blaming Our Patent System.

If a review should be given of the various comments and opinions that have appeared in newspapers and periodicals during the last few years on the defects in our patent laws and the remedies needed, it would be surprising to note with what general unanimity the critics place the blame on the system and the governmental end of same. The writers agree in that our patent system is still regulated largely by laws based upon a former industrial situation very different from that now existing, and that consequently these laws are in some respects inadequate and unsuited to present conditions. That the march of the years should have brought radical changes in the industrial adjustments of our nation and that these should require some readjusting of our laws is not surprising.

However, the same great changes have also affected the other two parties interested in the average United States patent, for there are usually three parties concerned in the issue of each such grant. Broadly speaking, every patent represents a compact between the people and an inventor, which compact is usually negotiated through a patent attorney or solicitor. Consequently, in any fair-mindea estimate of our patent system, there must also be considered any changes or shortcomings in the inventors and in the intermediaries through whom they utilize the existing patent laws. When this consideration is made, it is at once observed that human nature has by no means even closely approached the standards of perfection which have been held up before it for thousands of years. We find on the one hand that thousands of inventors have not measured up to the standards of men and women for whom the existing patent laws were framed. On the other hand, both business interests and intermediaries of various kinds have taken more or less unfair and unscrupulous advantages of the inventors seeking protection. When such advantages are taken by manufacturers, and particularly by prominent corporations, there arises a great hue and cry about the way capitalists are abusing the privileges of our patent system. Such a clamor is quite in harmony with the social unrest and tendencies of our times and, to a considerable extent, there is a foundation both for this excitement and for the changes in our patent laws for which so many are at present urging.

Much of this sharp and widely echoed criticism of our patent system is manifestly unjust in that it is concentrated almost wholly upon one of the three parties interested in the average compact which we term a patent. From its very nature, such a compact is a means for enabling the inventor or his assignee to secure a certain monopoly, hence a good share of the complaining on the part of inventors is simply the disgruntle of the unsuccessful would-be monopolist at the successful one. However, overlooking this phase ofthe situation, which adds a grim humor to the subject as a whole, and granting that a revision of the patent laws is needed to curb the unfair restraining of trade (particularly in regard to matters not directly covered by patents), are we justified in assuming that it is only the governmental end of the compacts that needs improving? Can we honestly

say that neither inventors nor those helping the same to their patents have not been abusing our patent system just as noticeably as the much berated capitalists and manufacturers?

At first glance, it might seem as if the inventor, particularly when disconnected from any considerable source of capital, could take no advantage of our existing laws that would be in any way unfair either to other inventors or to the general public. This might be true if successive patents did not depend so largely for their scope upon the range of those previously granted; if an excess of applications in any given line did not clog that branch of the patent office so as to delay action upon other cases in the same line; if every application (whether resulting in an issued patent or not) did not require the outlay of a considerable sum of money; and if the unremunerative patents were not frequently such a source of discontent and discouragement as seriously to affect the general working capacity and future of the patentees. Since none of these last named phases of the subject lend themselves readily to the muckraking type of journalism, they have been almost overlooked in recent discussions, and yet there is hardly a community of any size but that has felt the effects of such an abuse of patent privileges by some inventors and by those who thrive by coaxing patent applications out of a certain class of men and women. Just as the existing patent laws assumed a certain organization of our industrial system, so also they presupposed certain qualifications on the part of those applying for patents. They assumed each applicant to have sufficient intelligence and foresight not to apply for a patent unless his invention actually has some commercial standing or prospects; sufficient familiarity with his particular branch of the applied arts to make sure that his invention marks a radical enough departure to offer a basis for monopolizing trade in the same; and sufficient business judgment not to spend the money for obtaining a patent unless his finances warranted his doing so either as an investment or as a speculation.

Insofar as our patent system is utilized for its original purpose, namely, that of protecting the pioneer manufacturer who incurs heavy expenses in developing and introducing new articles or methods of manufacture, these assumed qualities are quite commonly found among the applicants for patent protection, to whom each such grant means a legitimate business investment. However, as pointed out by a writer in another column, the success of some such men in obtaining large financial returns from lines protected by patents has led others to assume that patents in general have an intrinsic value. This belief in turn has been spread by a certain class of patent procurers who thereby have succeeded in luring thousands after thausands into the expenditure of money for patents on articles or processes which had no commercial value to begin with. Of course, every sixty or hundred dollars thus spent on a practically worthless patent means just that much withdrawn from more legitimate uses, and the patentee often feels the resulting strain. Failing to receive the expected returns, he grows disgruntled not only at the patent office, but often also at our whole industrial system. Rarely does he realize that he himself was largely to blame and that the rest of his censure should more properly go to the piecework specification-factory in which his patent application was ground out by a cheap helper toiling at too swift a pace to do thorough work.

Direct and Indirect Lighting.

In most problems of illumination, either entirely directed or entirely diffused light is unsatisfactory and a combination of the two is required. Little exact knowledge exists on the proportion in which directed and diffused light should be combined for satisfactory illumination, nor how this proportion varies with the variation of conditions of objects to be illuminated. Elsewhere in this issue appears general remarks on the advantages and disadvantages of high indirect component and it appears from the investigations there presented that the direct component of illumination should be between 12 and 15 per cent.

The relations between directed and diffused light have often been obscured, in illuminating engineering practice, by the relation between high and low intrinsic brilliancy and between direct and indirect lighting. Cases have been found where a change to the system of indirect lighting, and the elimination of high intrinsic brilliancy, have been very satisfactory, and yet, other cases have been found where the absence of directed light made it not altogether satisfactory. Thus instances will be found where a low intrinsic brilliancy, which would provide a source of the proper proportion of directed light, in connection with the inverted system, or source of diffused light, would give an illumination that would be wholly satisfactory under no other conditions.

The main objection to directed light from a single source is the absence of light in the shadows. By using two or more illuminants that will direct light from different directions, the shadow cast by one is illuminated by the other and thus an effect is produced that is very similar to diffusion. In fact, an infinite number of point sources distributed through space would produce perfect diffusion. It is possible therefore to have too many point sources; so much so that there would be only diffused and no directed light.

Illuminating engineering as a science cannot overlook the fact that the main distinction of objects is due to differences in intensity or brightness and that for producing these qualities the shadows are of foremost assistance. The study of shadows is one of the most important subjects of illuminating engineering. If there were no shadows but instead a perfectly diffused illumination, even though the intensity of illumination were sufficient, the illumination would be unsatisfactory and objects would not be distinguishable. But in order to have shadows we have directed light, that is, light coming from one or a number of sources and it is for this reason that a number of small units sufficient to give illumination of the brilliancy desired and placed equi-distant above the line of vision is generally conceded to give the best illumination, provided, however, that a part of the light is reflected. For satisfactory illumination it is necessary to have sufficient directed light to mark the edges of the object by their shadows, thereby improving distinction, but at the same time, sufficiently diffused light to see clearly in the shadows. For good illumination it is, therefore, necessary to have the proper proportion of directed and of diffused light. In cases where objects have practically the same color, as in foundries, a diffused illumination without shadows would be almost useless.

The Parksville Development of the Tennessee Power Company.

(*Contributed to* SOUTHERN ELECTRICIAN.)

BY L. R. SCHENCK.

A Description of the Plant Constructed by the Eastern Tennessee Power Co., at Parksville, Tenn.

During the month of July, 1910, the Eastern Tennessee Power Company was incorporated under the laws of Tennessee, for the purpose of constructing and operating hydroelectric plants on the Ocoee river in Polk county and with power to sell electrical energy throughout the state. This company commenced work on a development at Parksville during the fall of 1910 and delivered power to customers in January, 1912, erecting a dam and power house with an ultimate capacity of 38,000 horsepower.

This development, besides being one of the first of any importance in Tennessee, is on account of its location an important factor in opening a section of the South where considerable industrial activity gives promise of taking place in the near future, and is one of several that will make up a connected system. With this end in view, the Tennessee Power Company was organized during the past summer, the Parksville plant of the Eastern Tennessee Power Company absorbed, and work commenced on a second development 13 miles above the Parksville plant where a diverting dam will be constructed from which the water will be conducted through a flume to a power house five miles below, where a head of 250 feet is secured and 20,000 kw. will be generated. In the construction of the Parksville dam, two openings were provided to which penstocks can be attached and lead to a power house about 400 feet below the dam. This development then will furnish 11,000 additional horsepower and will be operated for secondary power during periods of excess run-off. Other water rights are controlled on the Ocoee river, which falls some 600 feet in 25 miles of its course above Parksville. The development of these water powers will eventually produce 75,000 horsepower. The capacity of the plants now considered and making up a large part of this total power, is distributed as follows:

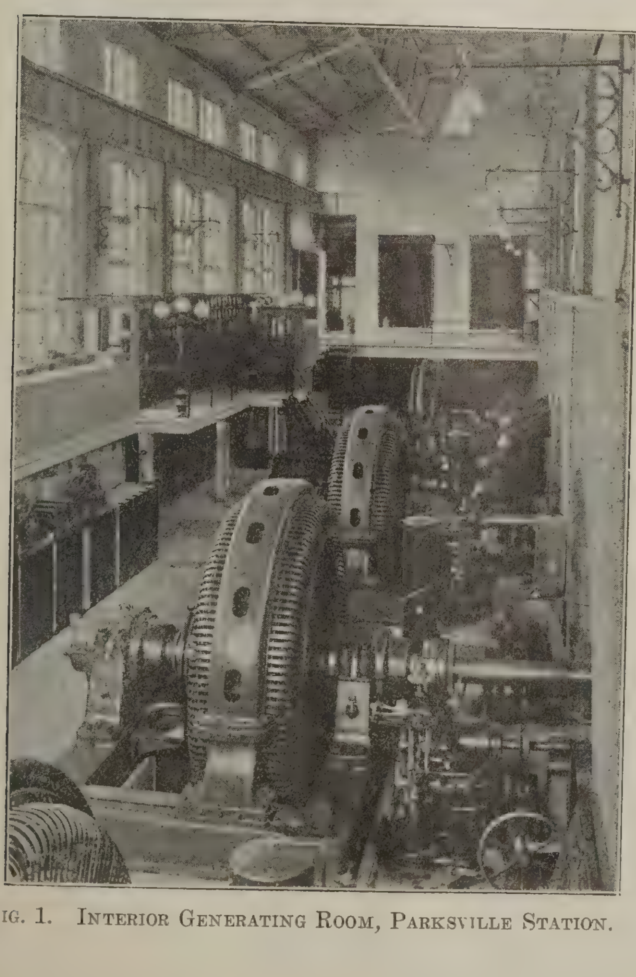


FIG. 1. INTERIOR GENERATING ROOM, PARKSVILLE STATION.

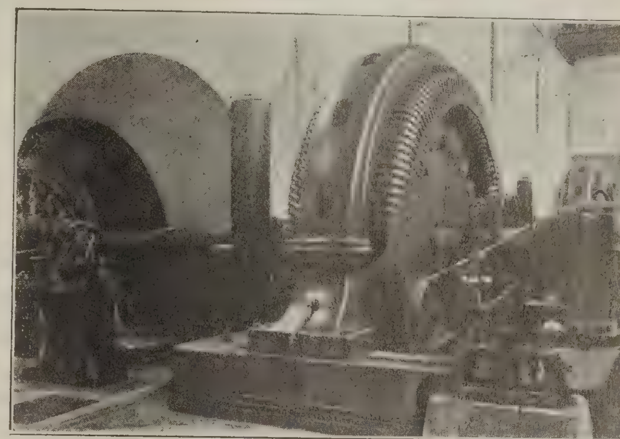


FIG. 2. SHOWING GENERATING UNITS, GOVERNOR AND TURBINE CHAMBER.

THE AVAILABLE POWER.	HORSEPOWER
Total ultimate capacity of Parksville development	38,000
Present capacity of turbines in Parksville power house	27,000
Capacity of secondary power development at Parksville	11,000
Capacity of second development on Ocoee river, now under construction	20,000

In what follows, the engineering features of the Parksville development will be taken up together with the transmission system it serves. As shown in the map in Fig. 3, the Ocoee river rises in the mountains of Northern Georgia and flows through a region of heavy rainfall in a northwesterly direction to a point near Parksville, Tennessee, where it joins the Hiawassee; in its course draining an area of more than 600 square miles. At Parksville the mountains have been cut by nature to form a deep and narrow gorge, above which the river flows for many miles through a broad and spacious basin, a location well suited to the purpose of water power development. Where the valley is narrowest, the Ocoee dam now stands, spanning a gap of more than 800 feet and filling the gorge to a height of 125 feet from the river bed. The river, held captive in the valley above, forms a lake eight miles long, covering an area $3\frac{1}{2}$ square miles in extent and containing 100,000 acre-feet of stored water.

THE PARKSVILLE DAM AND POWER HOUSE.

The dam is built of cyclopean masonry. It has a crest length of 840 feet, of which the spillway section is 362 feet long. The spillway is 12 feet below the main crest and is capable of passing a flood of 45,000 sec.-ft., with the water about 2 ft. below the crest of the dam. The maximum height of the dam from foundation to crest is 125 ft. in operation, and the additional main unit for which provision was made in the original plans is being installed. Each main unit consists of a pair of 39-in. special S. Morgan Smith horizontal wheels with a rated capacity of 5,400 hp when running at 360 r.p.m. under a head of 98 ft. Each main unit is connected to a 3750-kva, 2300-volt, 3-phase, 60-cycle Westinghouse generator. Each exciter unit has a single

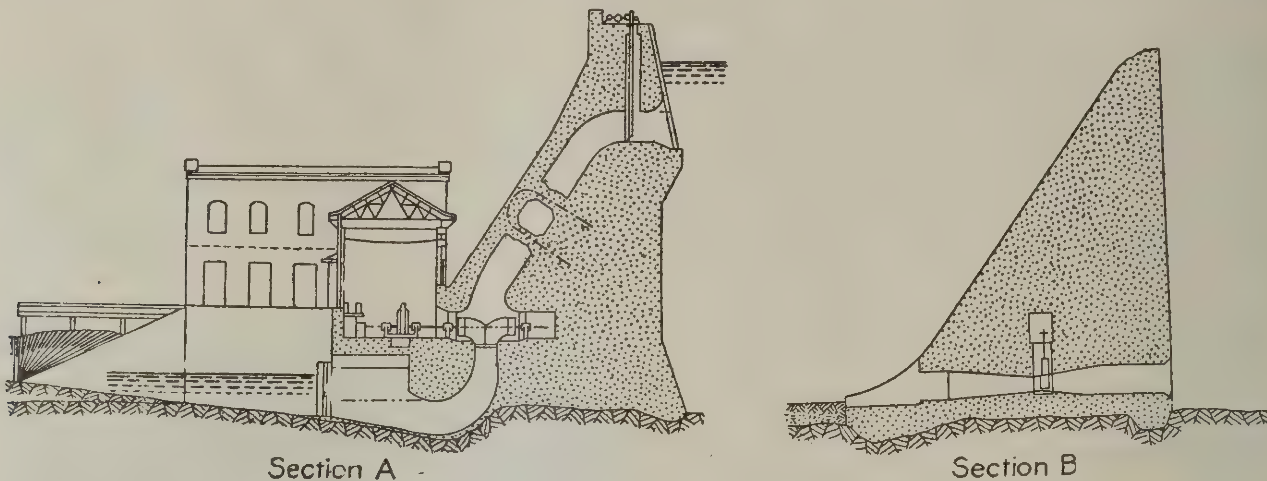


FIG. 4. SECTION THROUGH TURBINE UNITS AND DAM.

Five 11 x 11-ft. and two 4 x 4-ft. penstocks extend through the dam to the wheel chambers, also within the dam and connected by a service tunnel at the rear of the water wheels. Two more penstocks have been constructed in the dam to furnish water to a future addition to the plant.

The power house is situated immediately below the dam to the north of the spillway, its substructure being an integral part of the dam itself. The main building, 165 feet long and 35 feet wide, contains the generating apparatus. Four main generating units and two exciter units are

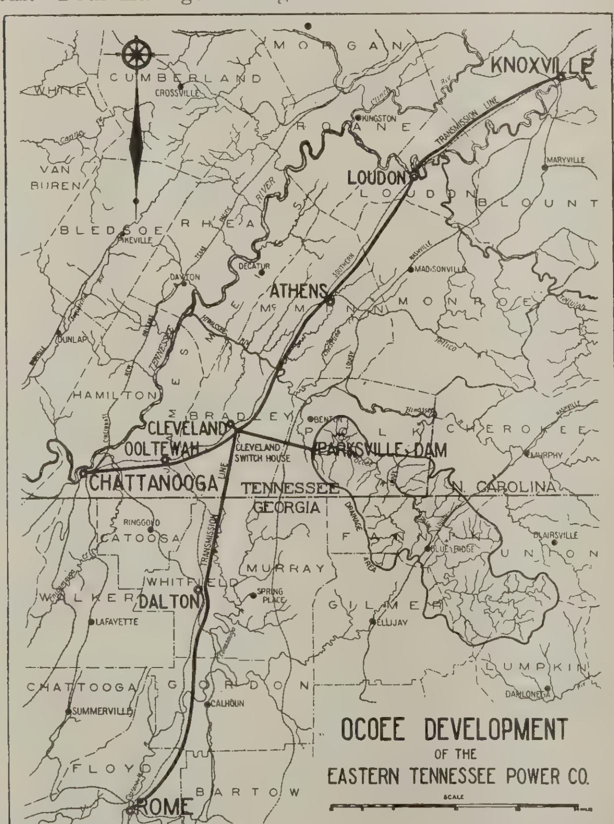


FIG. 3. MAP SHOWING TRANSMISSION SYSTEM OF TENNESSEE POWER COMPANY.

20-in. special S. Morgan Smith horizontal wheel in a spiral case, rated at 225 hp when running at 580 r.p.m. under a head of 98 ft., and a 120-kw, 125-volt D. C. Westinghouse generator. On the same shaft with each exciter there is also a 2300-volt Westinghouse induction motor.

There are four oil-insulated, water-cooled, 3-phase transformers, each having a capacity of 3750-kva, with a voltage ratio of 2300/66,000. Space is available for the installation of the fifth unit. The switching gear is of the remote-control electrically operated type, controlled by a switchboard on the operating gallery in the main generating room. The switch cells and low-tension busbar compartments are of concrete.

There are at present two outgoing high-tension circuits from the station, each circuit equipped with electrolytic lightning arresters. Provision has been made, however, for five outgoing circuits.

THE TRANSMISSION SYSTEM.

The construction of the transmission line was begun April 1, 1911, and on February 1, 1912, approximately 180 miles had been completed. The power developed is transmitted at 66,000 volts over two 3-phase circuits, to

FIG. 5. HIGH TENSION ROOM PARKSVILLE STATION.

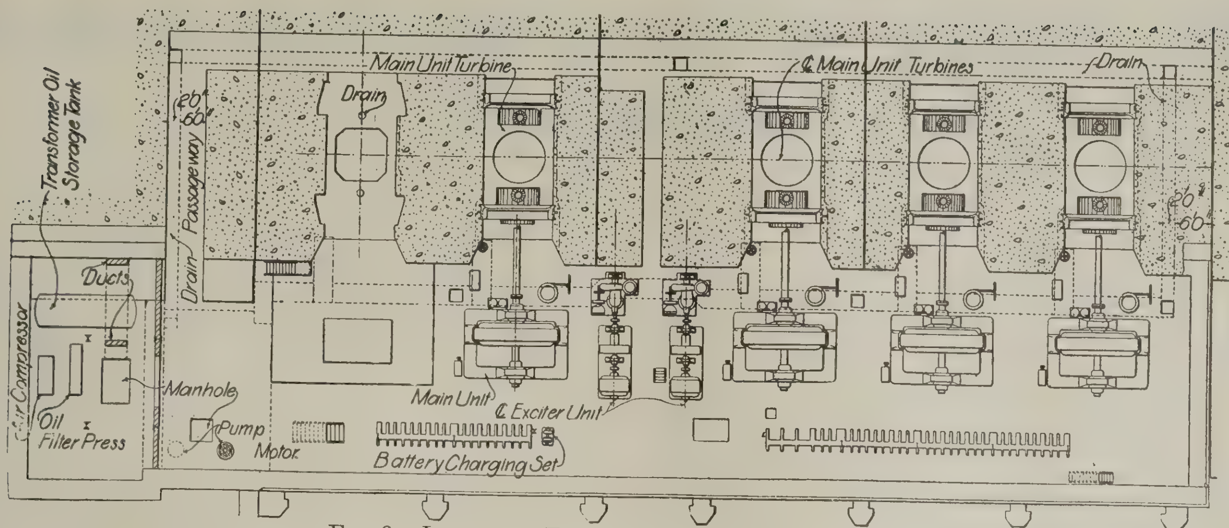


FIG. 6. LAYOUT OF EQUIPMENT IN PARKSVILLE STATION.

Cleveland, Tennessee, a distance of 13 miles from the power house. At the switching station in Cleveland the lines sparate and the current is carried over single circuit wood poles lines in three directions, 26 miles west to Chattanooga, Tenn., 85 miles northeast to Knoxville, Tennessee, and 70 miles south to Rome, Georgia. Special steel construction has been used wherever the lines cross railroads and rivers, or where for other reasons special strength is needed. On the Knoxville circuit the Tennessee river, which is navigable at this point, is crossed by means of a 1,800-foot span by steel towers 125 feet in height.

The wood pole transmission lines have 40-ft. chestnut poles for the standard height. Suspension insulators with four 10-in. Ohio Brass disks are used, supported by a wishbone-type steel cross-arm attached to the top of the pede. At present there are two No. 1/0 copper three-phase circuits from Parksville to the Cleveland, Tenn., switch house, a distance of about 13 miles, whence a single circuit of No. 1 copper runs about 26 miles to Chattanooga, a No. 2/0 copper line 85 miles to Knoxville, a No. 1/0 copper line 70 miles to Rome, Ga., and a No. 1 copper circuit one mile to Cleveland.

The switching house, about a mile from Cleveland, contains electrolytic lightning arresters and oil switches for two incoming and four outgoing circuits. These switches are electrically controlled from the power house of the Cleveland Electric Light Company and are used for the general load despatching of the system.

An abundant market is now found for light and power in Chattanooga, Cleveland and Knoxville, Tennessee; Rome, Georgia, and intermediate and adjacent points. Among the larger power users are the Chattanooga Railway & Light Company, the Cleveland Electric Company, a number of manufacturing plants in Chattanooga, Knoxville, Rome, Athens, and Cleveland, including numerous cotton and woolen mills.

The Ocoee development including the transmission system, was designed and built by J. G. White & Company, Incorporated, of New York City. For a part of this article acknowledgment is given to the Engineering Record in which appeared a more extensive article on the hydraulic and construction features.

Ceiling Fans in the Orient.

In a report by Consul General George E. Anderson, of Hongkong, it is stated that the use of the time-honored "punkah" or overhead fan, hung from the ceiling and agitated by a coolie pulling it from side to side, which has been characteristic of the East since first Western people have settled, is gradually disappearing. Its place is being taken by the electric ceiling fan. Few new buildings in Hongkong are fitted with punkahs, but all are wired with electricity with special reference to the use of ceiling fans.

There is little demand in this part of the world for desk fans and what demand there has been is giving way to the ceiling variety. Current from desk fans is too intense and is not well enough sustained for use in a heavy humid atmosphere. For the same reason the use of ceiling fans of high speed and narrow radius is not very successful. The best type of fan for this part of the world is a wide radius slow-speed two-blade fan with simple motor, as near foolproof as possible. Fans are used steadily in Hongkong and in other ports in a similiar latitude for about seven months in the year. The use of fans in the near future will doubtless increase rapidly. While punkahs have many merits, particularly in that their operation can be perfectly regulated under favorable circumstances and a gentle steady breeze can be maintained, there are a number of serious disadvantages attending their use, particularly in the loss of light they entail, in the fact that they do not promote ventilation as a fan does, and in the fact that they are hard to clean and often carry disease germs.

Of the electric fans now being sold on this market American fans have the preference, because they can be laid down at prices below those of other nations for similar goods. The actual volume of the trade can not be indicated in definite figures. Its general drift appears from the fact that the value of imports of electrical fitting and materials into all China increased from $915,596 in 1910 to $1,094,403 in 1911, in spite of the incidence of war and revolution. Hongkong itself probably will import and use an additional $200,000 worth of such goods. The present annual import of fans alone into Hongkong will probably reach a value of from $22,000 to $25,000 gold.

The Wiring of Shop Buildings of Steel Construction

(*Contributed Exclusively to* Southern Electrician.)
BY ERNEST G. BRADSHAW.

It is not the purpose of this article to treat in detail the methods of wiring used in all shops, but it will discuss certain methods that seem to be standard, to a certain extent at least, in some of the most modern plants and which, if followed, will provide an excellent installation.

A good general rule for wiring inside of steel mill buildings is to run all conductors larger than No. 8 B. & S. gauge open where they are installed above the roof truss chord and in conduit when below and on the side walls. Where the cost is not prohibitive, all No. 8 B. & S. gauge and smaller conductors are carried in conduit irrespective of location.

Heavy conductors may be carried on the lower chords of the roof truss as shown in Fig. 1. This is a good location, as the conductors are out of the way and not liable to be disturbed. At each truss the conductors can be supported by one of the methods illustrated in Fig. 2. With the method of Fig. 2a the conductor merely rests in the insulator, and the entire longitudinal strain is taken by strain insulators, attached to tightening bolts or turnbuckles, at the ends of the run. This method has the disadvantage that if the conductor breaks at any point, or is burnt in two, it will fall to the floor. The tie wire method of Fig. 2b is seldom used, though it is satisfactory if cleats are not obtainable. The cleat and through bolt method of Fig. 2c is probably the best, all things being considered. After the conductor has been drawn taut with the tightening bolts at the ends of the run, the cleat bolts are tightened and each cleat then assumes its share of the strain. Tie wires, which are unreliable and may cut into the insulation of the conductor, are unnecessary. Leather washers should be used between the insulator and bolt to prevent breakage.

For supporting conductors on steel angles, the Universal insulator support shown in Figs. 3 and 4 and accompanying table is a convenient fitting. It is of malleable iron and can be clamped on the flanges of steel beams, angles, channels, Z-bars and on round, square and flat bars. It can be also attached to gas and water pipes and to the edges of plates and tanks. Two insulators can be fastened to each support when necessary. Cup-pointed, case-hardened set screws are used. Leather washers should be used under the bolts that hold the insulators.

For supporting conductors on steel columns, a wooden base-board for the cleats, clamped to the column with hook-bolts, as in Fig. 5, is a good arrangement. The board must be cut out in back for the rivet heads in the column. Strap iron cleats, through which the hook-bolts pass, prevent warping and splitting.

Wire racks are used to support conductors, principally heavy ones, where there are many conductors in the run. The conductors should have flame proof or slow burning insulation. A wire rack can be made of wood fashioned into a frame work, somewhat along the lines of the steel ones of Figs. 6 and 7. With a wooden wire rack the cleats insulating the conductors are held to the frame with wood screws, or preferably, with machine or stove bolts.

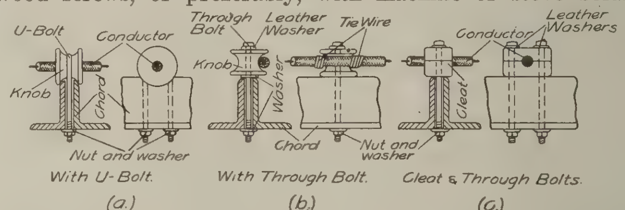


Fig. 2. Method of Attaching Knobs to Truss Chords.

A commercial wire rack with a cast iron base that can be bolted to any surface, is shown in Fig. 8. Generally a steel frame rack is preferable to a wooden one. The rack of steel angles of Fig. 6 was designed for installation in the top of a pipe tunnel. The insulators are held to the cross angles with bolts, with a leather washer under the head of each. The steel rack of Fig. 7 is arranged for supporting from a ceiling. Angle crossarms can be used, as in Fig. 7b, or the cross arms can each be formed of two iron straps, as in 7a. With the two-strap method, drilling for the cleat bolts is unnecessary, and the cleats can be shifted along the arm into any desired position, and there clamped fast. Strain insulators engaging in turnbuckles

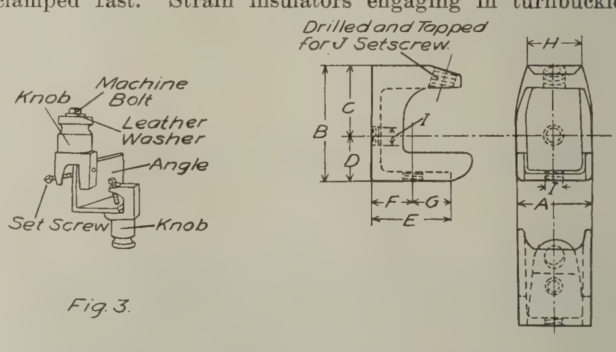


Fig. 3.

A Size Inches	For Insulator Numbers	B Inches	C Inches	D Inches	E Inches	F Inches	G Inches	H Inches	I Dia. of Tapped Hole Inches	J Dia. of Setscrew Furnished Inches.
1	5, 5½	1½	7/8	5/8	1 1/16	9/16	1/2	3/4	1/4	5/16
1½	10, 4, 4½	1¾	1¾	5/8	1½	9/16	3/4	3/4	5/16	7/16
2	3½, 24 1, 3, 3, W.G.	2	1	1	2	1	1	3/4	3/8	1/2
2½	25, 29, 34	2½	1¼	1¼	2½	1¼	1¼	3/4	1/2	5/8

Fig. 4.

Figs. 3 and 4. The Universal Insulator Support and Its Application.

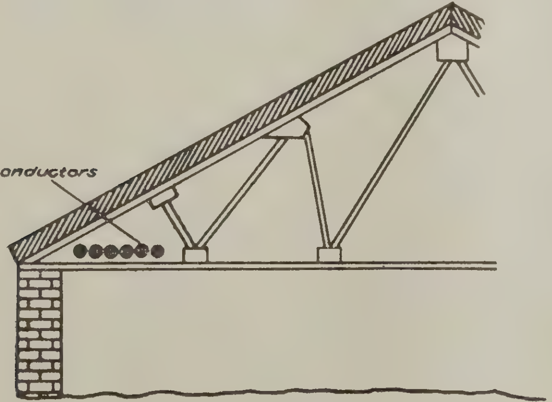


Fig. 1. Conductors Carried on Roof Truss.

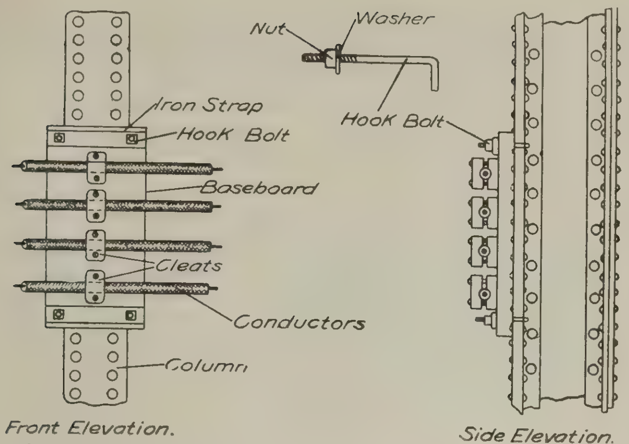
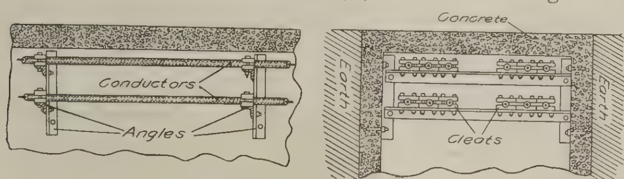


Fig. 5. Attachment of Wiring Board to Column.

or tightening bolts should be used at the ends of each straight run, to assume the strain and to provide for tightening, or else the arms and cleats at the run ends should be reinforced to assume the stress that will come on them.

At the ends of all important open-wire runs of wires larger than, say No. 8, strain insulators engaging in some wire tightening device should be used. Fig. 9 illustrates some methods. Either tightening bolts or turnbuckles can be used. The strain insulator may be of the type extensively used in trolley line construction, as in (a), (b) and (c), or it may be a heavy knob (d) held to the tightening



6. Iron Rack for Conductors.

device with stout wire. Where a run changes directions a cable clamp can often be used with economy, particularly with large conductors. (See Fig 9c). The cable clamp, a patented device, consists of two forgings so arranged that they can be bolted on the cable at a point where it has been "skinned" for the purpose. One of these forgings extends and is attached to one end of a strain insulator; the other end of the insulator being anchored in the wall or similar support in the usual manner. Where there is a tension on both sides of the bend, two clamps should be used as in Fig. 10. When a cable clamp is used, it is unnecessary to cut the conductors to change its direction, and the necessity of making up turns around the line wire, as in Fig. 9, (a) and (b), is eliminated.

Rigid iron conduit wiring is approved by the Underwriters for all classes of wiring, and for ordinary conditions probably provides the best, although the most expensive method. The advantages of rigid iron conduit are: 1. It is fire proof. 2. It is moisture proof. 3. It is strong enough mechanically so that nails cannot be driven through it and so that it is not readily deformed by blows or by wheelbarrows being run over it. 4. It successfully resists the normal action of cement when imbedded in partitions or walls of fire proof buildings.

Lined and unlined iron conduit can be obtained. The lined conduit is merely ordinary conduit lined with a paper tube that is treated with an insulating water proof compound. The lining is cemented to the interior of the conduit by the compound.

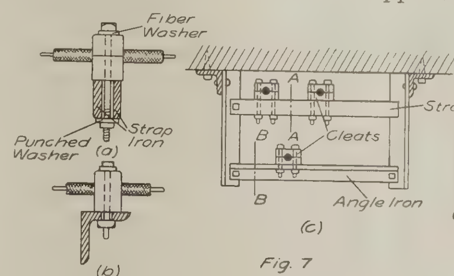
The advantages of unlined conduit over lined conduit are: 1. It is cheaper, because it has no lining. 2. It is cheaper to install, as it can be bent, threaded and cut more readily than can lined conduit. 3. It is easier to draw wires into and out of unlined conduit than into and out of lined conduit. 4. In lined conduit, in hot places, the conductors sometimes stick to the lining, which prevents their withdrawal.

The disadvantages of unlined conduit are: 1. The unlined iron conduit may rust through, due to the combined action of water or steam and the chemical elements in ash or other cements. 2. Double braided conductors must be used in unlined conduit, to satisfy code rules. The increase in cost due to this requirement is slight compared with the greater cost of lined conduit and the cost of installing it.

Lined conduit is very seldom used now. It sometimes finds application where every precaution must be taken to protect against trouble that might occur if the outer iron tube rusted through.

Sherardized or galvanized iron conduit should be used if conduit is installed out of doors or in damp places, or where it is imbedded in cement.

Elecctrical conduit is merely commercial standard-weight wrought-iron pipe that has been carefully reamed inside to remove burrs and then treated with zinc, or an enamel, baked on, to prevent rust. The threads on the ends of conduit lengths are standard pipe threads. Hence, where Underwriters' inspectors do not have jurisdiction, iron pipe can be used instead of conduit. The pipe is cheaper, and in dry locations it appears to serve as well



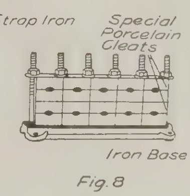


Fig. 7. Another Form of Rack. Fig. 8. A Commercial Rack.

as conduit. A coat of black stove pipe enamel on the outside of the pipe will give it a finished appearance, and more than a superficial inspection is required to distinguish a pipe so treated from conduit. It is the practice in some industrial plants, where the buildings are all of fire proof construction and where no insurance is carried, to use galvanized iron pipe instead of conduit.

Conduit containing feeders should run as straight and as direct as possible to the outlets or panel boards; it being a safe rule to follow that there shall never be more than the

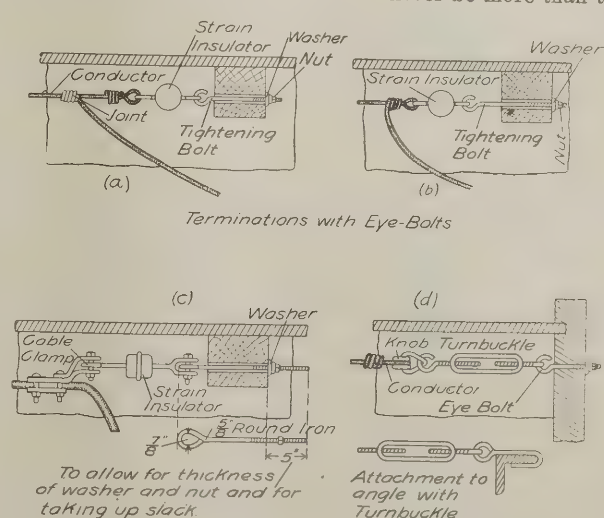


Fig. 9. Methods of Terminating Conductors.

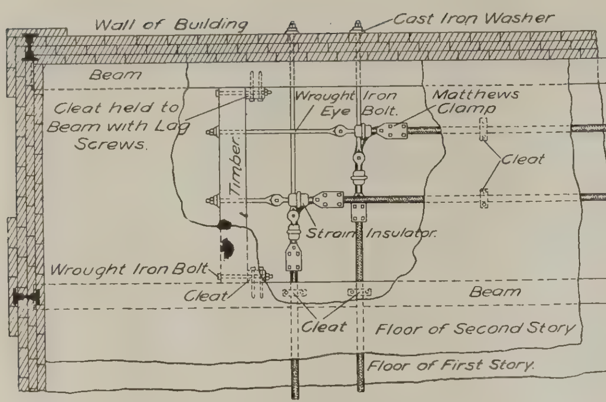


Fig. 10. A Right Angle Turn Showing Use of a Cable Clamp.

equivalent of four right-angled bends between drawing-in outlets. Whether the branch conduits shall run parallel to the lines of the building, or whether they shall run from outlet to outlet in a direct line, is a question to be settled by governing conditions.

All bends should be made with a large radius—a radius of two or three feet being the best. Short bends render it almost impossible to "pull in" the conductors. Should it be necessary to insert more than four large radius bends or a smaller number of short radius bends, it would be wise to use, for at least one of these bends, an outlet conduit elbow fitting. There are many different kinds of these fittings on the market, each satisfying its particular application better than some other type. An examination of the manufacturers' catalogues will usually indicate which is best for a given purpose.

It is possible to readily pull conductors into a long run if it is a straight one, but when there are one or more bends in it, it becomes much more difficult. The presence of several bends in a run make it necessary to put in an

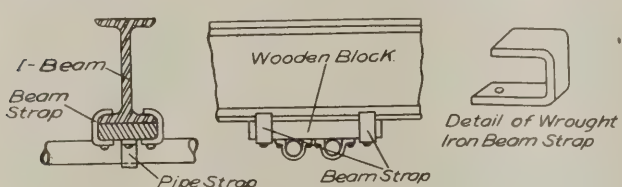


Fig. 11.

Fig. 12.

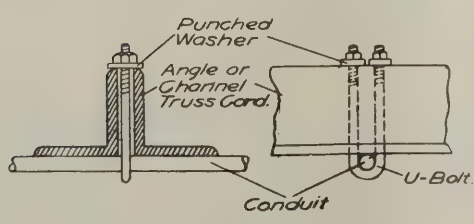
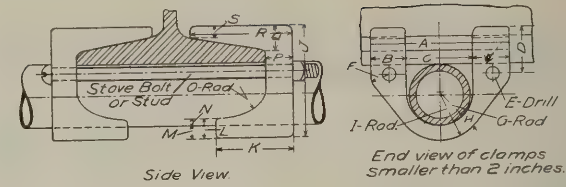


Fig. 13.

Fig. 11. Application of a Beam Strap. Fig. 12. A Specially Forged Clamp Supporting Conduit to I. Beam. Fig. 13. A U-Bolt Clamping Conduit to Truss Chord.



Size Conduit Inches	Dimensions Inches																		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1/2	2 5/16	11/16	15/16	3/4	5/16	11/32	15/32	1/4	23/32	1 11/16	1 1/2	3/8	1/4	1/8	1/2	1/2	11/32	1 1/2	3/16
1/2	2 5/16	11/16	15/16	1 1/8	5/16	11/32	15/32	1/4	23/32	2	1 1/2	3/8	1/4	1/8	1/2	1/2	15/32	2 1/8	3/16
3/4	2 1/2	11/16	1 1/8	1 1/8	5/16	11/32	9/16	1/4	13/16	2 1/4	1 1/2	3/8	1/4	1/8	1/2	9/16	15/32	2 1/8	3/16
1	3	3/4	1 1/2	1 7/32	5/16	3/8	3/4	1/4	1	2 5/8	1 5/8	7/16	1/4	3/16	11/16	9/16	33/64	2 3/16	1/4
1 1/4	3 1/4	3/4	1 3/4	1 3/16	5/16	3/8	7/8	1/4	1 1/8	2 29/32	1 5/8	7/16	1/4	3/16	11/16	9/16	33/64	2 3/16	1/4
1 1/2	3 1/2	3/4	2	1 3/16	5/16	3/8	1	5/16	1 5/16	3 3/16	1 7/8	1/2	5/16	3/16	11/16	9/16	33/64	2 3/16	1/4
2	4	3/4	2 1/2	1 1/4	5/16	3/8	1 1/4	5/16	1 9/16	3 3/4	1 7/8	1/2	5/16	3/16	1 1/8	5/8	37/64	2 1/4	5/16
2 1/2	4 3/4	7/8	3	1 15/32	5/16	7/16	1 1/2	5/16	1 13/16	4 1/2	2	9/16	5/16	1/4	1 1/4	11/16	41/64	2 5/16	3/8
3	5 3/4	1	3 3/4	1 5/16	5/16	1	1 7/8	3/8	2 1/4	5 1/8	2 1/8	9/16	3/8	3/16	1 1/4	11/16	41/64	2 3/8	3/8
3 1/2	6 3/4	1 1/4	4 1/4	1 3/8	5/16	1 1/4	2 1/8	1/2	2 5/8	5 11/16	2 1/4	11/16	1/2	3/16	1 1/4	13/16	11/16	2 15/32	7/16
4	7 1/2	1 3/8	4 3/4	1 7/16	5/16	1 3/8	2 3/8	1/2	2 7/8	6 1/4	2 1/4	3/4	1/2	1/4	1 1/4	13/16	29/32	2 7/16	1/2

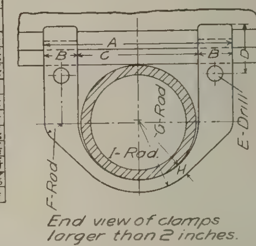


Fig. 14. I-beam Conduit Clamps and Dimensions.

outlet. Some wiremen make it a practice to use outlet elbow fitting at each bend. This renders the pulling of wire through the conduit easier, but it has the disadvantage that the resulting job is not as neat as one where well-bent conduit is used, and unless more rigid support is provided than is necessary with the bent conduit, the work will be less secure and less durable.

Another protection against the hard pulling in of conductors is the use of conduit of a large size. Tables can be found in electrical handbooks which show the best size of conduit to use for a given size of conductor. A study of these tables will give one an idea of what is the proper size for any particular service.

There are many possible methods of supporting conduit on the structural work of buildings. A little thought and ingenuity will often enable one to devise new schemes for special conditions. A few of the most common are illustrated here.

By far the most popular is the pipe strap. This can be used to fasten the conduit to the wooden parts of the building with wood screws. Also, by drilling holes in the steel columns, girders and trusses, the conduit can be fastened to these members by pipe straps and bolts. This method, however, is rather expensive, as it involves considerable time to drill holes, and for this reason is prohibitive except where a very permanent and neat job is necessary. Another arrangement and a cheaper one than that just mentioned for supporting conduit on the steel structure is shown in Fig. 11. A wooden block is fastened to the column or truss by small wrought iron beam straps, and the pipe straps carrying the conduits are fastened to this block by wood screws or nails. The block can also be supported on the column as in Fig. 5. By the use of one of these methods the conduit may be run either parallel or at right angles to the member.

Where the conduit is to be supported by an I-beam, or two channels or angle-irons, and must run parallel to them, the method of Fig. 12 may also be used. The clamp shown in this figure must be specially forged. It is not on the market, but where many are required a form can be made and it can then be produced very cheaply.

Where it is desired to support conduit to members fabricated from two channels or angle-irons and to have the conduit lie at right angles to the channels or angles, the method shown in Fig. 13 may be used to advantage.

Where it is necessary to run the conduits at right angles to beams, the I-beam conduit clamps illustrated in Fig. 14 may be utilized. Their principal advantage is that they draw the conduit up firmly against the I-beam and grip it very firmly. In a multiple conduit run, each conduit can be secured to a given beam, each with its own pair of clamps. Where the clamps are used on conduits in a group that lie

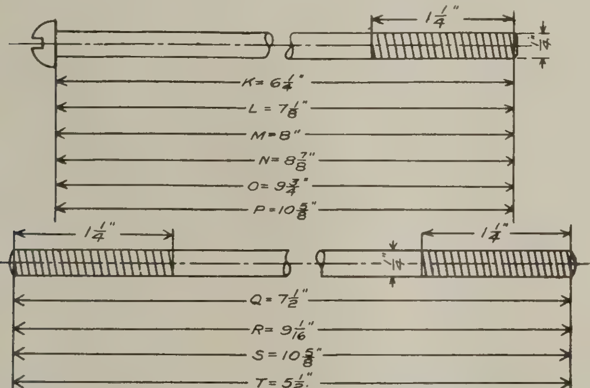
close together, the stove bolts should be used in preference to the studs, so that one can draw them up with a screw driver. For a single isolated conduit either studs or stove bolts can be used.

Fig. 15 shows the size of the stove bolts, or of the studs that should be used with a given I-beam and aconduit of a given size. Stove bolts of the sizes indicated are regularly manufactured, but not always readily obtained. The studs can be easily made by threading the ends of ¼-inch wrought iron rod. In cramped locations the nuts on the studs can be tightened with plyers.

Fig. 16 shows a method of supporting conduit to any column or truss, and the pipe may run either parallel or at right angles to the member, as desired. The fitting used here is the Universal insulator support, described in the discussion on open wiring.

Wire for use in unlined wrought iron conduit must be double-braid, rubber-covered. Single-braid wire is permitted in lined conduit, which is now very seldom used. Each conductor must be continuous from outlet to outlet without splices or taps. The same conduit can contain as many as four two-wire or three three-wire circuits of the same system, and be in accordance with code rules.

The same conduit must never contain circuits of different systems. Duplex wire, particularly No. 14, is largely used for branch circuits in conduit wiring. Solid wire is used for conductors up to and including No. 6. Conductors



Diameter of Conduit Inches.	Size of I-Beam, Inches.								
	4	6	7	8	9	10	12	15	18
½		K	K	K	K	L	M	N	O
	T	Q	Q	Q	Q	Q	R	R	S
¾		K	K	K	K	L	M	N	O
		Q	Q	Q	Q	Q	R	R	S
1		K	K	K	K	L	M	N	O
		Q	Q	Q	Q	Q	R	S	S
1¼		K	K	K	K	L	M	N	O
		Q	Q	Q	Q	Q	R	S	S
1½		K	K	K	K	L	M	N	O
		Q	Q	O	Q	Q	R	S	S
2		K	K	K	K	L	M	N	O
		Q	Q	Q	Q	Q	R	S	S
2½		K	K	K	L	L	M	N	P
		Q	Q	O	Q	Q	R	S	S
3		K	K	K	L	L	M	N	P
		Q	Q	Q	Q	Q	R	S	S
3½		K	K	L	L	L	M	O	P
		Q	Q	Q	Q	R	R	S	S
4		K	K	L	L	L	M	O	P
		Q	Q	Q	Q	R	R	S	S

FIG. 15. DIMENSIONS OF STOVE BOLTS AND STUDS FOR CONDUIT CLAMPS OF FIG. 14.

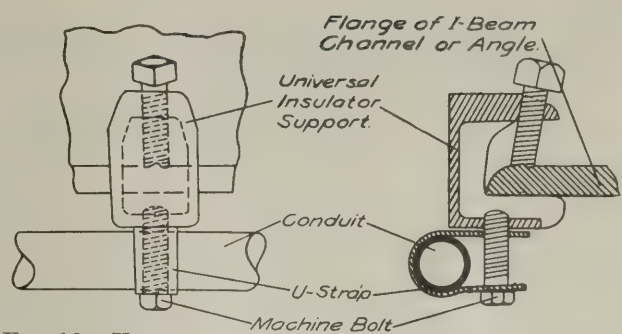


FIG. 16. UNIVERSAL INSULATOR SUPPORT USED TO CLAMP CONDUIT TO I-BEAM CHANNEL OR ANGLE.

larger than No. 6 are stranded so that they can be readily pulled into the ducts.

Where alternating current circuits are in conduit, all of the wires (two wires for a single-phase, three wires for a three-wire or three-phase, and three or four wires for a two-phase circuit), of the circuit must be carried in the same conduit, to prevent inductive voltage drop and dangerous overheating of the conduit.

A Transmission Voltage of 150,000.

Transformers for a 150,000 volt transmission line have been constructed by Allis-Chalmers Company, of Milwaukee, Wis. They are 4,000 kv.a. single phase, 60 cycle, oil filled, water cooled transformers for service on the Pacific coast on the lines of the Nevada-California Power Company. These transformers are designed for 36,000 and 6,600 volts on the low side and 87,000 volts on the high voltage side. Three transformers form a group which will be connected in "delta" on the low voltage side. The high voltage side is connected in "Y" to give 150,000 line voltage. The transformers are designed for an insulation test between high voltage and low voltage coils or between high voltage coils and iron of 300,000 volts, alternating current, for one minute. The principal dimensions are as follows: Diameter of base, 8 feet 10 inches; height to top of cover, 15 feet 8 inches; height to top of high tension terminals, 19 feet 10 inches. With normal supply of cooling water these transformers will carry a full rated load for 24 hours with a temperature rise not exceeding 40 degrees centigrade. They will carry 25 per cent overload continuously with a temperature rise not exceeding 55 degrees centigrade. Each transformer complete with oil weighs about 43 tons, and the efficiency at full load will, it is claimed, be considerably over 98 per cent.

Resuscitation Chart and Booklet.

The National Electric Light Association has had a Commission on Resuscitation from Shock at work for some time past. Their labors have finally issued in the publication of a chart and a booklet giving rules and regulations which should be followed, based upon the Shafer, or prone method. A large edition has been published of both the chart and the booklet and they can be obtained at the secretary's office. The chart is so prepared that it can be placed upon a wall or notice board, while the booklet can be placed in the pocket and is bound in stiff cloth for that purpose. The prices are 3 cents per copy for the chart and 5 cents for the booklet, sufficient only to cover the cost of printing and mailing.

Central Station Service in New York City During 30 Years

A Contrast Between Equipment and Service of the Early Days and That of Today.

THE first thirty year period of Edison service in New York City was completed on September 4th, 1912, at three o'clock, for on the afternoon of Monday, September 4, 1882, the generators in the power plant of the Pearl St. station started on their career of supplying light and power to New York City. The old Edison Electric Illuminating Co., was then the only commercial central station in the world operating an underground system for distributing current for incandescent lighting. The three decades already covered in the city of New York therefore present the whole history of electrical generation and distribution as a commercial factor.

In view of the fact that a review of the anxiety and interest in a wonderful mystery, that has now become so common as to give up much of its secrets, is a matter of interest to all central station men, we present in what follows, an abstract from a very interesting account of early electric lighting in New York as presented in the October issue of the Edison Monthly.

"The Edison Company was organized in 1880. The following year the property in Pearl Street was purchased, consisting of two old brick-wall warehouses with wooden floor-beams and floors. The building was thereupon "gutted," only the outside shell being preserved. Then a steel core was constructed with steel floor-beams and columns and cement floors. Boilers occupied the space from basement to second floor, where were installed engines of 125 horsepower to drive the dynamos—officially known as the Edison Steam Dynamo "Jumbo."

"At a later date, when the Company installed an engine of 300 horsepower it was officially known as the "Big Engine." Again this title was given to the 625 horsepower which followed, and also to the 1,250 horsepower, which was known as "Big Harry." When the 2,500 horsepower arrived, weighing over 450,000 pounds, the Company realized how the word "big" had been misused in the past, and the latest engine remained unnamed.

"The six "Jumbos" started to work at 3 o'clock in the afternoon of Monday, 4th of September. Truly, an epoch-making day, and yet one of the most expensive of the New York dailies dismissed the fact with a brief comment that "the Edison central station was yesterday one of the busiest places downtown, and Mr. Edison was by far the busiest man in the station. The giant dynamos were started up at 3 o'clock in the afternoon, and according to Edison, 'they will go on forever, unless stopped by an earthquake.'" That was all. The *Sun* under heading—"Edison's Light Turned On"—states, "Two engines were started last evening . . . the Drexel Building, containing one hundred lights; the *Times* Office, the Park Bank and the *Herald* Office were among the places lighted last night by electric current from the station in Pearl street."

"The New York *World,* under "Edison's Incandescent Light," says: "Most of the principal stores in Fulton Street, from Nassau Street to East River, were last evening for the first time lighted by the Edison electric light." The New York *Herald,* under "Edison's Illuminators": " . . . Last night it was fairly demonstrated that the Edison light had a very fair degree of success."

"Comments in the New York *Times* on their own installation in 1882 sound delightfully naive in the year 1912. "The whole lamp looks so much like a gas burner sur-

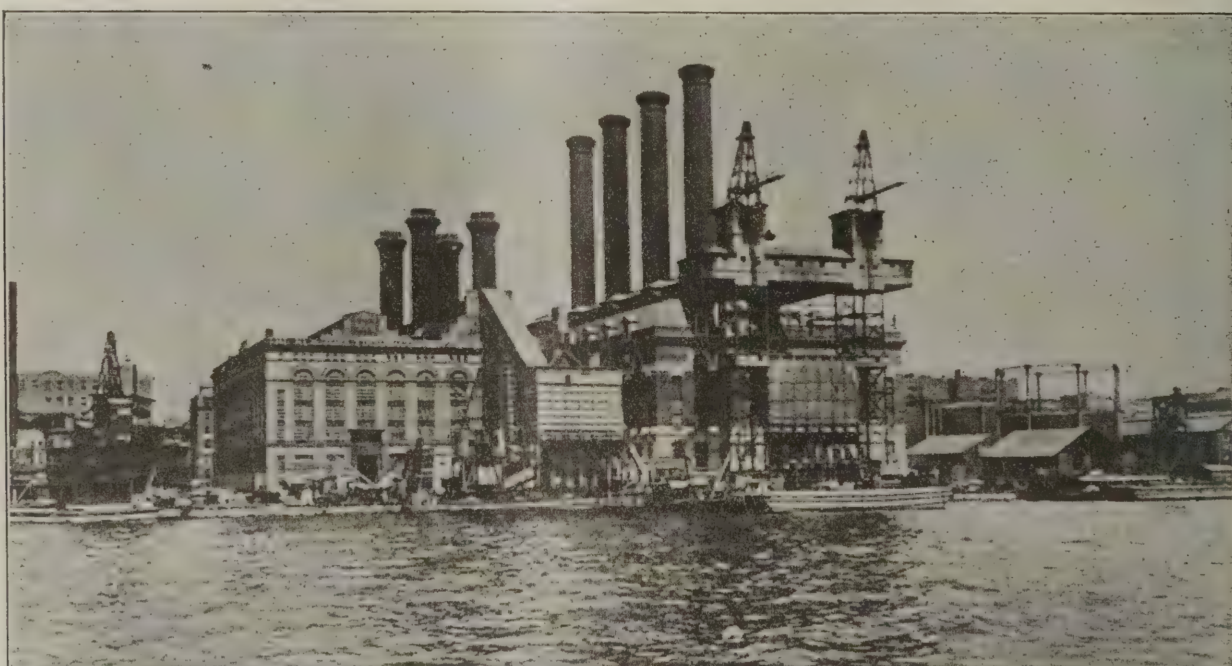


FIG. 1. THE WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.

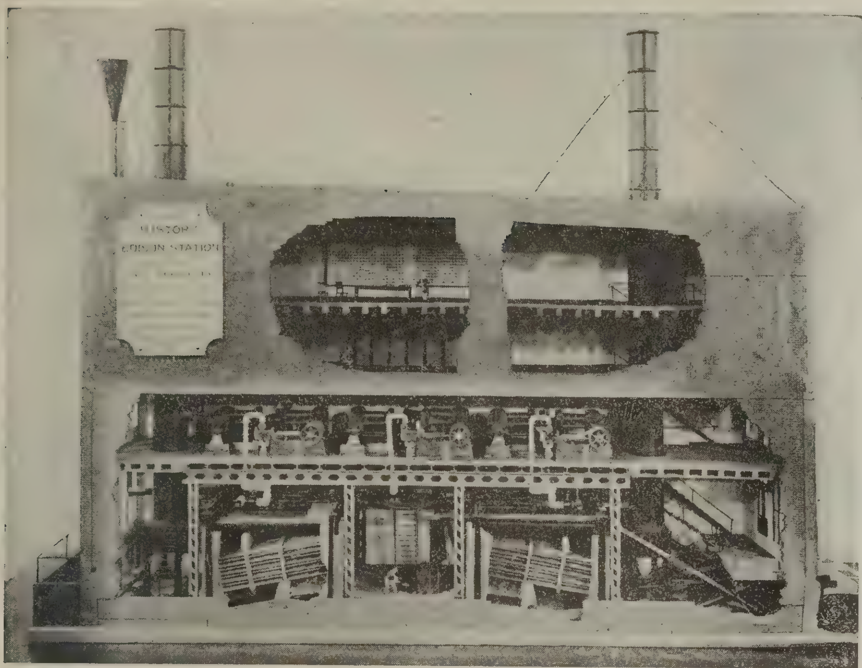


FIG. 2. MODEL OF NEW YORK'S FIRST CENTRAL STATION,

mounted by a shade that nine people out of ten would not have known the rooms were lighted by electricity, except that the light was more brilliant than gas and a hundred times steadier. To turn on the lights nothing is required but to turn a thumb-screw—no matches are needed, no patent appliances. As soon as it is dark enough to need articial light, you turn the thumb screw, and the light is there, no nauseous smell, no flicker, and no glare."

"The old Bishop Mansion—65 Fifth Avenue—leased in 1881, was then the headquarters of the Edison Company. At that time the Bishop mansion was one of the finest in the city. It became a veritable bee-hive of industry.

"Edison was always a good judge of a cigar and fond of a good one—so were his friends. He complained pathetically one day that his cigar box lasted only one day and a half. My friend suggested that he knew a party nearby in Eighth Avenue who made a superior grade of cigars, and who would show them a trick. He would make up some cigars with hair and old paper and I could put them in my desk without a word and await the result. I thought no more of the matter. Months afterward my friend returned. 'How did that cigar business work?' he inquired. I did not remember anything about it. On coming to investigate it appeared that the box of cigars had been duly delivered and put in my desk and, without doubt I had smoked them all! I was too busy on other things to notice."

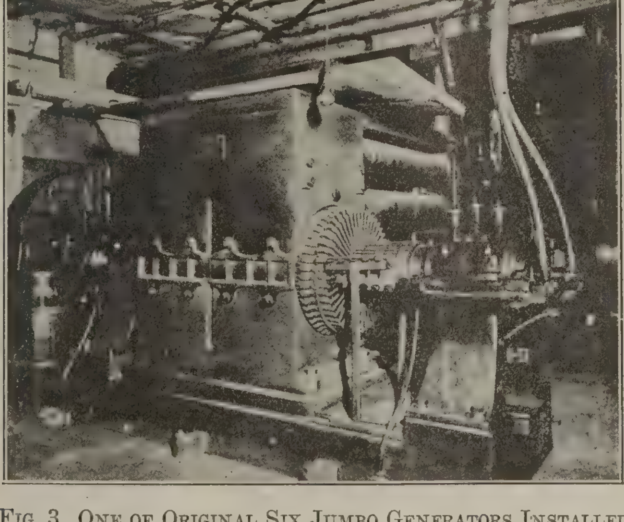


FIG. 3. ONE OF ORIGINAL SIX JUMBO GENERATORS INSTALLED IN FIRST STATION.

"For months, day and night, prior to the opening of the Central Station, Edison gave his constant attention to the work and personally supervised every detail—including work in the trenches—everywhere helping by his wonderful knowledge, energy and example to hasten the realization of his ideal—the Central Station."

There are many of our readers who will remember the events related in the above paragraphs. It is hardly possible for those connected with the industry only a short time, to realize that New York, now the foremost city of the Western Hemisphere, containing the largest central station in the world, should gain this position in such a very short space of time. Yet such has been the growth of the central station industry.

While September 4th, 1882 is distinctly the first date in commercial central station work, yet the 3rd of November, 1911, is also another important one, for on that date at 11:14 A. M. the most powerful machine in the world for generating electricity was started at the Waterside station of the present New York Edison Co. This mighty steam turbine generator is rated at 30,000 horse power and carries the load of seven generators which it replaced, occupying a floor space of a little more than one of them. The size of this machine is shown in Fig. 4. Its height is 35½ feet above the base, and its horizontal dimensions are 17½ by 17 feet, while it occupies an area of 297 square feet. The total weight is 420 tons. Further 400 tons of coal are consumed by it every day in making the 7,200,000 pounds of steam which it daily uses. For condensing the steam 86,000,000 gallons of water are required each day.

Instead of the small building of the early 80's housing the original generating apparatus, the present company has two immense structures which are shown in Fig. 1, and thirty-one substations to generate and distribute electrical energy throughout New York and neighboring boroughs. At the present time the net work connecting these stations represents nearly 1,300 miles of mains, feeders and cables in the underground system and supplies current for all of Manhattan Island having an area of over 21 square miles, and the Bronx besides with an area of 40 square miles. To record the energy consumed through this system, the company has connected to its lines 159,000 meters through which are fed over five and a quarter million lamps. In addition to this demand on the system, there are operated 40,400 arc lamps, 337,200 horsepower in motors. This is quite in contrast with the system some thirty years ago

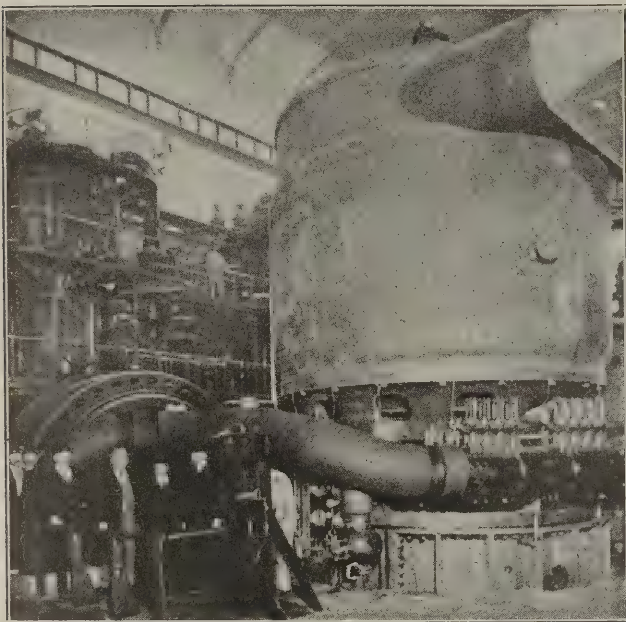


Fig. 4. A 30,000 Horsepower Steam Turbine Generator at Waterside Station.

with about 15 miles of mains and feeders, supplying 59 customers with about 400 lamps.

The development of the New York Edison System to accommodate the rapidly but gradually increasing demand upon the system has been taken care of well in advance of this demand. After the first Pearl Street station had been added to in capacity through an annex at 60 Liberty Street, the first new station was placed in operation, namely the 39th Street station, on Thanksgiving Day, 1888. On Christmas Day of the same year the 26th Street station was also started. The Duane-Pearl Street station began its operation on May 1st, 1891 and the fourth was at 115 East 12th Street. The first Waterside station was opened in 1902 where sixteen vertical engines with a capacity of 8500 hp each were installed. In 1906 a second Waterside station was opened with a capacity of 103,000 kw.

The original Pearl Street station, where the six Jumbo generators were installed, continued operation until 1890 when fire destroyed the building and only one of the dynamos was saved. This generator was on exhibition at the recent New York Electrical Show. At the time of the fire, the Liberty Street Annex of the Pearl Street station took the load and service was interrupted less than eight hours. With the exception of this interruption and another, the two aggregating less than 12 hours, the Edison service in New York City has been continuous since the first day a dynamo started.

It is now a matter of interest to know that the original plan for the central station system of New York was to locate some thirty-six independent stations south of 59th Street, each to be equipped with its own steam generating equipment. The introduction of high tension transmission changed all this and made it possible to concentrate generating apparatus and give to the industry and the New York company the largest equipment in the world. The combined capacity of the two Waterside stations is now about 700,000 hp, and they contain three of the immense steam turbine generators already mentioned, each capable of developing 30,000 horsepower each. Current is generated at 6,600 volts, three-phase, 25 cycle, and is distributed through substations in Manhattan and the Bronx, 31 in number. On Manhattan Island the current is transformed to direct current at 120 and 240 volts by means of rotary converters in substations, while for the Bronx district a three-phase alternating system at 2,000 volts is maintained, where for local service a secondary voltage is obtained at 104 to 208 volts. In the city proper, namely, Manhattan Island, the distribution system is entirely through underground conduit, while in the Bronx district many overhead lines are used. The total area served, namely Manhattan Island and borough of the Bronx, by the New York Edison Company approximates sixty-two square miles. There is at present nearly 1,300 miles of cable underground, 360 of which are used for high tension transmission. The original 400 incandescent lamps has swelled to five and a quarter million, and the connected total load equals 714,000 hp, consumed by 120,000 customers.

Patents or Patented Money-Earners.

(*Contributed Exclusively to* Southern Electrician.)

BY ALBERT SCHEIBLE, RESEARCH ENGINEER AND PATENT ATTORNEY.

Among the curious misconceptions which persist year after year in the minds of the general public, is the idea that a patent has a value in itself, and the companion notion that patenting an invention adds to the intrinsic value of the latter. No doubt these beliefs have sprung partly from the thought that any right for which one has to pay a considerable sum must have a decided value. However, the very term, "Letters Patent," only means a documentary evidence of a certain right and any value attaching to the same must come from the profitable utilization of this right. Unless the same can be utilized to advantage, there will be no value to it, even if a costly document gives some one the exclusive monopoly of this right. But if the nature of the right is such that it can be exercised profitably, then the securing of an exclusive grant for a term of years may enable the holder of that grant to reap handsome returns. When this has occurred in the past, the returns have often been so loosely attributed to the grant or patent as to give many the impression that part or all of the intrinsic value resided in the latter.

This misconception has been increased by the somewhat misleading wording of the United States patents, which read as if granting "the exclusive right to make, use and vend the said invention throughout the United States and the territories thereof." Although this is the exact phrase used on the face of each patent, the latter really accords such a right to the inventor only in so far as he does not trespass upon the rights of others with his invention; that is, it only grants him the right to prevent others from making, using and vending his invention. Whether he himself is free to do

so is not adjudged by the Patent Office and in this respect the wording of the issued patents is often sadly misleading. The situation is about as if one party were granted the exclusive use of a certain lane, enabling him to collect toll from all passing along the same. He would be able to exclude any other; but if some one else controlled the road leading to this lane, even he himself could not get into it without the consent of the other party. In any event, his possible toll collections from the lane would depend on the number of persons or vehicles traveling the same. If it is unfrequented, or if it is paralleled by other lanes leading to the same terminus and sharing the traffic with it, his chances of earnings would be very small and his formally obtaining the control of that particular lane would not increase the amount of these possible earnings. There must be an earning power to begin with, and no added formality can supply this.

The same holds true in the case of new devices, methods or machines. Unless each one has in itself the possibilities of being a money-earner, no patent or grant of an exclusive right to it can legitimately make it profitable. The fact that others have reaped handsome returns from devices of intrinsic merit and good commercial prospects by utilizing the rights of patentees in restricting competition and maintaining good prices, does not in any way prove that a patent on a less meritorious or even commercially unpromising article, would also lead to profits. While this point would seem to be an exceedingly simple one, it has not generally been understood and the fact that shrewd inventors and manufacturers nearly always profit by our patent laws, has led some to the impression therefore, that it was the patent and not the inherent fitness of the invention or its commercial prospects that made the invention profitable.

This misconception in turn has been fathered and exploited by patent procurers who are eager for earnings, and who realize that these earnings would be greatly curtailed if they confined their practice to inventions of real promise. Indeed, the literature of the more prominent of these procurers is remarkable for the cleverness with which it transfers the emphasis from the inventing to the patenting. "Fortunes in Patents," advertises one, illustrating his point by quoting the total annual earnings of the Pullman Car Company; the Singer Sewing Machine Company; the Bell Telephone Company, etc.; "Money in Patents," says another who adds: "There is no Science, Industry, Art or Profession that offers such an opportunity for wealth as invention." And how are these fortunes to be obtained? The same literature gives the recipe, beautifully simple: "Get busy. Look about you. Invent some little novelty, toy or household article; it will prove a money-maker when properly protected by a patent." Thus instead of pleading for patents as proper means of protecting money makers, these quantity-patent-application-enticers give out the impression that it is the patent in itself which makes the new idea a money-maker.

Then if the reader wants a further clew, he is offered long lists of "Inventions Wanted," which make interesting reading, most of the items being reprinted from issues compiled ten or twenty years ago. Their accuracy may be inferred from the following statements in a booklet just being circulated by a Washington concern: "An electrical gear for changing the speed and torque of electrical apparatus is also to be desired. Strange to say, nothing along this line has been invented, and in view of the present improvements in dynamos and the like, such gear is badly needed." (Why anyone should want to change the torque of a dynamo is not stated).

"The manufacturer of electrical apparatus is compelled to rely for his conducting castings upon the present process of manufacture which builds up the castings, such as generator covers, from laminated sheets."

What is the result of all this? With the emphasis thus transferred from the careful evolving of an article worthy of being controlled by a patent, to the hasty patenting itself, almost any crude idea will answer, provided there is a sufficient touch of novelty about it to permit of some distinctive claim. How narrow this claim will have to be, is rarely considered. The aim is simply to get a patent, for the patent is looked upon as an end in itself and not merely as a means to the desired end. Here again the patent procurer meets the would-be inventor more than half way with his "no patent, no pay" guarantee, which says in effect: "Tell me your idea and I will guarantee to twist some wrinkle of it into a basis for a patent, or else I will refund a part of the fees paid to me, provided," etc. (Here follow some loop-holes, through which no layman is apt to see).

Lured on by such methods, the amateur inventors usually bite, get some sort of patents and then wait for returns. When these fail to materialize neither the public as a whole nor those interested in the same general field with each patent are likely to extend any sympathy. Even those interested in lines in which patents play an important and legitimate part, only smile. What matters it to them if the year 1911 added 60 non-refillable bottles, 110 nut-locks, 50 electric switches, etc., to the large number on which patents have not yet expired? And yet it should matter to them for several reasons, not the least of which is the extent to which the unwarranted surplus of applications clog the patent office and often delay action on cases of real merit which must take their turn with the rest.

An extremely limited and commercially impossible invention may have just enough novelty about it to hinder a more thorough inventor later on in obtaining the broad patent to which his really commercial work should entitle him. Again, the costs of obtaining a commercially worthless patent is just about the same as for one covering a meritorious and actually needed invention and every such expenditure of (say) eighty dollars withdraws just so much from other uses. Indeed, if every applicant for a patent could be made to show his qualifications for designing a really commercial invention, or else could be required to spend twenty or thirty dollars in taking a preliminary course to ground him on the fundamentals of the line in which he is working, the inventor himself would be far better off and the annual saving to the nation as a whole would mean an enormous sum.

While such a requirement may not be feasible, particularly as even correspondence instruction along the lines of invention has been available to but few, it ought at least to be feasible to curtail the "Get-rich-quick" literature offered to inventors. In the electrical field in particular, it seems inexcusable that some notoriously "half-baked freak" inventions should even be presented to the patent office, and if the inventors of the same have so slight a knowledge of the commercial side of the electrical field as to believe that such ideas can bring returns for them, then it is high time that both the government and the electrical fraternity joined in stopping this wanton luring of the ignorant with its resulting detrimental effects alike on the inventor, on those depending upon him, and on the allied industries.

Alternating Current Engineering

(*Contributed Exclusively to* Southern Electrician.)

BY WILLIAM R. BOWKER.

Section 13-A. Control of Variable Speed and Single-Phase A. C. Motors.

IN the section published under this heading in the September issue, the control of variable speed A. C. motors was discussed using a variable resistance inserted in the secondary rotor circuit. Speed variation of this class of induction motors can also be obtained by potential control or variation of the impressed voltage applied to the primary stator winding. This method is not as efficient, however, as the rheostatic control above mentioned.

The potential control as applied to the stator by varying the impressed voltage of the primary circuit, gives a lower power factor and decreased efficiency to all speeds below full normal speed. The rheostatic control on the other hand gives the same power factor at all speeds, but with considerable loss in resistances at all speeds below full speed.

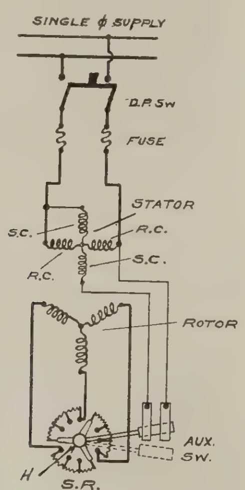


Fig. 76. Heyland Method of Starting a Single-Phase Motor.

Another method of feed control is by varying the number of stator poles. This, however, demands a somewhat complicated switching device for changing the number of stator poles if a variety of speeds is desired. It possesses advantages from a practical standpoint, admitting of a fairly high efficiency at half speed, due to no wasteful rheostat losses.

A motor with an 8-pole stator can have its poles so grouped that it may be changed to a 6 pole or 4 pole stator. It can be changed from an 8 pole to 4 pole stator, by suitably connecting to a double throw triple pole switch. A motor with the number of its poles doubled will run at one-half the speed it had previously.

An extremely ingenious and efficient method of starting a single-phase motor is that known as the Heyland Starting Device, which provides for and possesses the practical advantage of being able to start a single-phase non-synchronous motor under load with a considerable starting torque. The diagram of connections are shown in Fig. 76, which circuit contains a double pole switch, fuses, the starting and running coils of the stator, the rotor windings and its starting resistance, etc. S C represent the starting coils of the stator, which are only in circuit at the time of starting. R C are the running coils, which practically short-circuit the supply lines after the starting coils are automatically cut out of circuit. S R is a starting resistance inserted in the rotor circuit. To start the motor ,the auxiliary switch is pushed over to the position as shown, the double pole main switch is then closed and the current flowing through the stator windings splits between the running coils and starting coils. The phase is displaced by the interaction of inductance and resistance, the starting winding offering less resistance and greater inductive effects than the running coils, the starting field is stronger than the running field, which affords a condition that results in a considerable starting torque.

The rotor now revolves by the action of induced currents and its three-circuit starting resistance is gradually cut out of circuit by rotating the handle H, which at the same time releases the automatic switch, finally cutting the starting coils entirely out of circuit. When the motor is running at full speed, the rotor windings are short-circuited. To stop the motor, pull the main double pole switch, and after the motor comes to rest, return the rotor starting rheostat and the automatic stator starting coil switch to their start positions. This starting arrangement necessitates that the stator field be wound with two separate sets of coils. In practice this arrangement of starting a single phase motor on a single phase supply is equivalent to starting the motor by an artificially induced two-phase or polyphase current.

In Fig. 77 a method is shown for operating a three-phase motor on a single-phase current supply. The stator and rotor of a three-phase motor, is shown where R is a non-inductive ohmic resistance, C, a self-induction or impedance coil and P S a double pole phase switch. The motor has the usual three-phase primary or stator winding and a three-phase winding on its rotor secondary. The stator is connected to the secondary of a step down transformer. In the primary of the transformer is connected a non-inductive resistance R and the self-induction coil C and by means of the phase switch these can be put in and out of circuit.

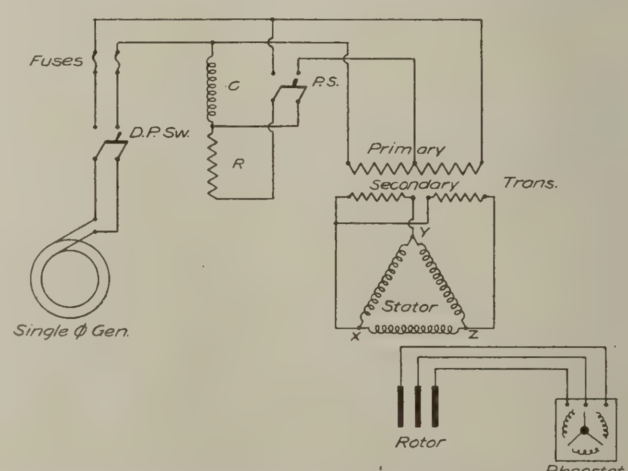


Fig. 77. Method of Operating a Three-Phase Motor on a Single-Phase Circuit.

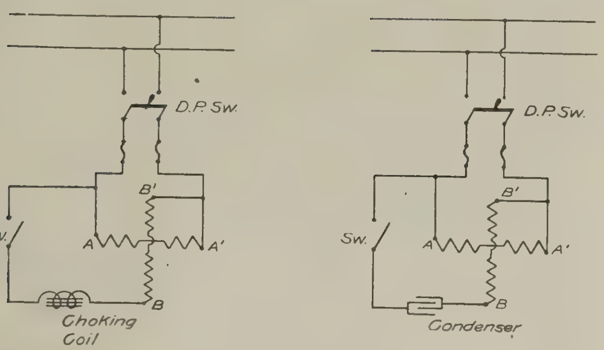


Fig. 78. Fig. 79.

FIGS. 78 AND 79. STARTING METHODS FOR SINGLE-PHASE MOTORS.

To start the motor, the double pole main line switch is closed and likewise the phase switch, which action produces a sufficient displacement of phase to start the motor. The rotor circuit current can be varied by means of the rheostat, thus starting under load, the resistance being gradually cut out as the motor attains speed; after which the phase switch is opened and the reaction of the rotor three-phase winding induces a current in X Y Z of the stator winding, which continues to run as a three-phase motor, although supplied with only a single-phase current. The stator windings are connected to the two ends and middle point of the secondary circuit of an ordinary split transformer.

To stop the motor, open the main circuit switch, and return the rotor rheostat to its starting position. At starting, the phase switch should be closed either a little before or simultaneously with the closing of the main switch; otherwise overheating of the transformer would ensue if the phase switches were neglected to be placed in circuit.

As previously mentioned, a single-phase motor will become self-starting if during starting we supply it with a second current, which differs in relative phase to the main phase current. This condition can be fulfilled by inserting in a branch auxiliary circuit, a choking coil that possesses self-induction, as outlined in Fig. 78, which shows only the primary stator circuits and auxiliary apparatus, it not being necessary to show the rotor winding. In this sketch A A is the main phase winding of the stator connected directly to the mains, and B B, an additional auxiliary phase winding, in the circuit of which there is connected a choking coil in series. This produces a lagging effect, due to self-induction and resultant retardation, and likewise a relative phase difference between the currents in the main and auxiliary phases. This affords the required condition to produce self-starting.

An arrangement that attains the same object is shown in Fig. 79, the only difference being that a capacity in the form of a condenser is utilized in the auxiliary phase circuit. The action of this is to result in a leading effect giving a phase displacement.

Sometimes the effect of both induction and capacity are employed for starting a single-phase motor, a choking coil being inserted in one circuit and a condenser in the other. A phase displacement can also be produced by using ohmic resistance in one winding.

A reversal of the direction of rotation of a single-phase alternating current motor by electrical means requires an auxiliary phase circuit. When there is no auxiliary phase in circuit no change of connections are necessary, because it has no tendency to rotate in one direction in preference to the other. It all depends upon which direction it is mechanically rotated previous to the current being switched on. A single-phase induction motor with an auxiliary phase circuit behaves like a two-phase motor. Figs. 78, 80 and 81 illustrate respectively the method of connecting the several terminals so as to get a clockwise rotation and a counter-clockwise rotation of the rotor.

Two methods of obtaining a counter clockwise rotation are shown, one is to reverse the main phase connections as in Fig. 80, and the second method is to reverse the connections of the auxiliary phase as in Fig. 81. The single-phase motor cannot, however, start under full load, its starting torque being limited to a part of its full normal load.

It is very convenient and service requirements sometimes demand that the automatic starting and stopping of the squirrel cage type of induction motors be operated from a remote point. This automatic remote control can be attained by means of a push button, float-switch, pressure governor, etc., in combination with a contactor type of compensator. These automatic compensators are supplied and utilized for two and three-phase motors and at all practical voltages and frequencies.

In Figs. 82 and 83 diagrams are given of the essential circuit connections for the automatic remote control of a three-phase and two-phase motor respectively, in which a single pole switch is the remote starting or control switch or its equivalent. To start the motor, the single pole switch is closed, when the contactors A B C D E, in the three-phase motor circuit and A B C D G E, in the two-phase motor circuit should immediately close. This action energises the relay J, which raises a plunger against the action of a dash-pot located beneath the relay.

Following this action the rod located at the top of the relay J will quickly elevate the lever T, which breaks contact and opens the circuit at *S*. at the same time making contact with and closing the circuit at *R*, which action will take a period of time of, say, 10 to 20 seconds, depending upon the size of the motor operated. When contact is broken at S the contactors A B C D E, in the case of the three-phase motor and contactors B D G E, in the two-phase motor circuit will open and after opening, and contact has been established by lever T at R, the contactors F G H, Fig. 82, and F H, Fig. 83, close, when lever T drops back to S breaking circuit at R, the relay J being de-energised by interlock K. A careful study of Figs. 82

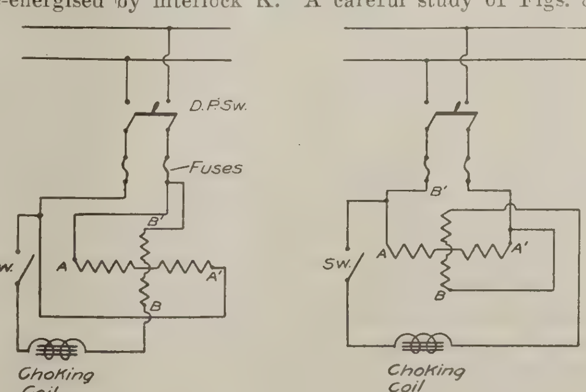
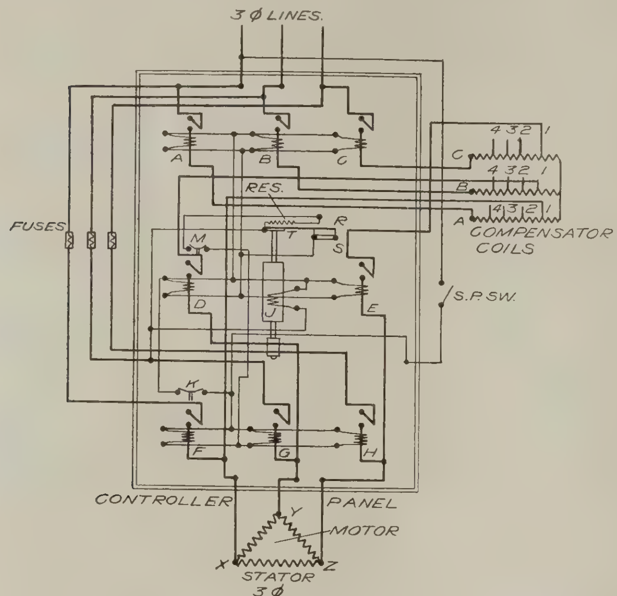


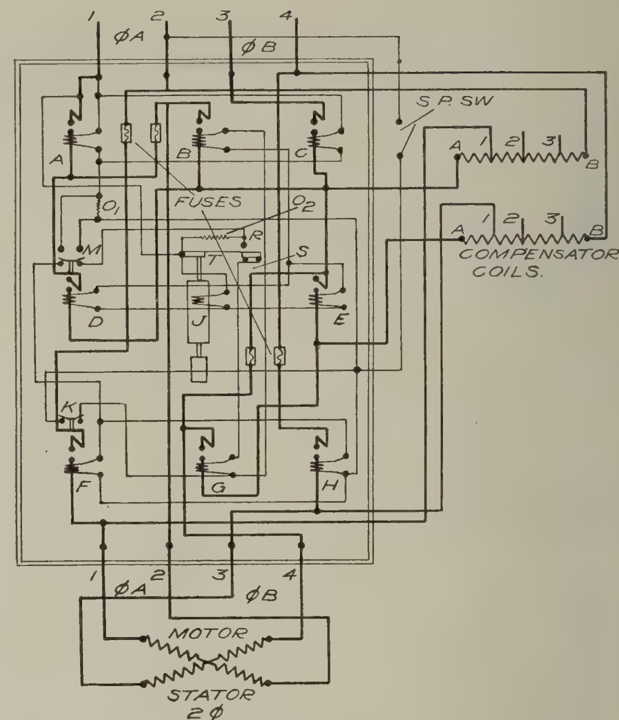
Fig. 80. Fig. 81.

FIGS. 80 AND 81. METHODS FOR REVERSING ROTATION OF SINGLE-PHASE MOTOR.

and 83 should result in a clear understanding of the principle of action of the remote control.

The arrangement is an automatic starting method of potential control, where the compensator or auto-transformer taps 1, 2, 3, 4 can be connected in circuit so as to produce





Figs. 82 and 83. Diagrams for Automatic Remote Control of Three-Phase and Two-Phase Motors.

a variable starting current and torque by varying the impressed voltage across the stator terminals at starting, as demanded by service requirements. To start the motor, the remote control switch A is closed, which puts into circuit, referring to Fig. 82, the contactors A B C D E, the compensator coils and the stator windings of the motor. The path of the current is by the supply lines to the contactors A B C and then to the terminals A B C of the autotransformer through the coils and from in this case the lowest voltage taps of the three-phase windings marked No. 1, that of C-1 passing through contactor E and finally to terminal Z of the stator windings. The other circuits are by way of A-1 direct to stator terminal X and by way of B-1 and contactor D to motor terminal Y. The motor thus speeds up, and should have attained approximately full speed by the time T is elevated or breaks circuit at S; which opens the circuit at contactors A B C D E, cutting the compensator windings entirely out of circuit. The stator circuit now receiving full line impressed voltage owing to the contactors F G H automatically closing simultaneously with the opening of contactors A B C D E. The path of the current now is direct from the supply lines through the protective fuses, then by way of contactors F G H to stator motor terminals X Y Z, the opening of contactors A B C D E, automatically cutting out of circuit the auto-transformer, its function only being necessary during starting. It must be understood that this method of remote control is used only with the short-circuited squirrel cage type of rotor.

Conditions, Practice and Developments in English Central Stations.

(*Contributed Exclusively to* Southern Electrician.)

CECIL TOONE, AN ENGLISH CONSULTING ENGINEER.

Section 4b. Water Driven Stations. Continued from November Number.

In the early days of central station development quite a number of stations essayed to harness rivers running through their boundaries, but, in most cases, the schemes either proved impracticable on closer examination or concealed their limitations till the die was cast and the stations were in operation, with the assistance of more or less steam plant added, under compulsion, as an afterthought. It is true that analogous misfortunes dogged the early development of suction gas plant, thus, the town of Lynn possesses a handsome suction gas plant occupying the best sites in the producer house engine room and so on, while a steam-driven set, tucked away in one corner, does the work. Again, Coatbridge abandoned its Dowson gas plant (1895), after one year's trial. But, whereas these misfortunes were evolutional incidents more than compensated by the experience gained with a new class of plant, the troubles in English water power stations have been attributable, not to the water wheels or turbines, but to the rivers themselves, a source of trouble which is, unfortunately, permanent.

The available head on most English streams is very inconsiderable, but the chief difficulty lies in the prevalent summer drought and (even more common and serious) winter flood. Quite a number of English towns might have admirable water-driven electrical stations if the lay of the

country for miles downstream did not make any effective tail race improvements impracticable. Water storage, to carry the station over the peak load in times of drought, is also impossible, in the majority of cases, to any effective extent. The capital cost of the requisite auxiliary plant, together with the often high cost of erecting the station on the banks of the river, owing to the inferior natural foundation available, usually makes water-driven stations impracticable in this country.

ACTUAL WATER POWER STATIONS IN ENGLAND.

So far as the writer is aware, there are only five central stations in the United Kingdom depending entirely on water power. As shown by Table 1, these are all small company-owned concerns and do not differ greatly, in the respects considered, from gas and oil stations of similar total capacity. The two larger stations employ Escher Wyss turbines and of the smaller undertakings, one has a horizontal "British Empire" turbine and one a "Samson" vertical shaft, mixed flow turbine. Keswick, the first opened water power station in England, commenced supply in 1890 with a 63-hp. "Victor" Kapp set, to which a second similar unit was subsequently added. At a yet later date, two "Universal" steam-driven sets were installed, so that the station now comes under the "Mixed" heading.

The most recently proposed water station in this country provides for the utilization of $3 \times 160 = 480$ hp. from the R. Dee at Chester. The average available head is 6.6 feet, and, allowing for the variable flow, an annual output of 1,273,000 B.T.U. per annum is anticipated at a total works cost of 0.624 cents per kw. hr.

TECHNICAL NOTES ON WATER PLANTS.

As will be seen from Table 2 below, the average "head" utilized by English hydro-electric stations is absurdly low as judged by Continental or American standards. The flow is equally insignificant and is, for instance, 2,500 cubic feet per minute at Grassington and 5,900 cubic feet per minute at Salisbury. At Worcester the total flow varies

TABLE 2. DATA ON WATER POWER PLANTS.

Place	Average Head	Total KW from Water Driven Plant
Fladbury	5.5-6.0	30
Salisbury	7	46
Grassington	8	20
Worcester	10*	360
Keswick	20	120
Ingleton	25-30	22.5
Limavardy	30	100

*Head varies from 3 ft. in winter to 16 ft. in summer.

from 20,000 to 60,000 cubic feet per minute, but owing to the restricted area of the canal supplying the works and the limited turbine capacity, only 26,000 cubic feet per minute can at present be utilized. So variable is the flow that the output of this station varies from 3,500 kw. hrs. per diem in spring and autumn to 250 kw. hrs. per diem in summer and nothing during the period of extreme flood. Here, as in many other cases, great improvements have gradually been made by improving the head and tail races during periods of drought so as to conform more nearly to the conditions which experience shows to be desirable. At times of reduced head, arrangements are made, wherever possible, to run part of the plant on full load, rather than the whole plant at a fraction of the rated load on each part. Similarly, reduced loads on the station are supplied by one or more generating units running under as high a percentage of full load as can be arranged. The maximum efficiency attainable with such small units as are here concerned seldom exceeds 60 to 70 per cent, and this figure diminishes rapidly as the load decreases.

The largest water-driven units employed in English central stations are of 100 to 150 kws. capacity and the diameter of the water wheel usually lies between 2 feet and 5 feet (40″-50″ being a common range). The water turbine is, of course, preferable to the water wheel by reason of its higher efficiency and speed, the latter enabling the avoidance of the transmission losses in at least one gear or belt stage. Nevertheless, some gearing is still necessary, the speed of the fastest water turbines being usually considerably lower than that desirable at the dynamo shaft. Hard wood and cast iron or steel gears are used in a number of cases, while in other instances, belts or ropes are employed. Standby plant being generally inevitable, it is usual to drive the generator from a countershaft, to which the water and reserve plant can be coupled independently or simultaneously as required, or to arrange for direct engine drive in case of low water. Steam engines have been mainly employed as reserve equipment in the past; gas and oil engines are now in limited use and there is likelihood of petrol engines finding some application as standby plant in very small undertakings.

STATIONS WITH MIXED EQIPMENT.

The necessity for standby equipment in water power stations, resulting in a mixed overall equipment has already been explained. In such cases, there are practically twice as many generating units for a given station capacity as

TABLE III.—COMPARISON OF STEAM, WATER, GAS AND OIL STATIONS.

Station KW Range	STATIONS DRIVEN BY							
	Water	Steam and Gas	Steam and Oil	Steam and Water and Oil	Water and Oil	Water and Gas	Gas and Oil	Total
(a) 0/100	3	1	1	—	2	1	—	8
(b) 100/250	3	1	3	—	—	2	1	10
(c) 250/500	1	1	3	1	—	1	1	8
(d) 500/1000	1	5	6	—	—	—	—	12
(e) 1000/2500	—	2	—	—	—	—	—	2
Total	8	10	13	1	2	4	2	40

would be required by a single reliable equipment. It is to this cause that the higher average number of generating units per station in the "mixed equipment" undertaking (see Table 1) is largely attributable. From Table 3 it will be seen that water—and oil—or steam-driven stations constitute the greater part of those coming under group (a); water and steam or gas-driven stations total half of those included in (b), but, in the larger stations, steam and gas or steam and oil equipments are mainly concerned. The various engines and generators employed in the "mixed equipment" stations are too diverse to yield any specially significant results on analysis. All the leading makers of steam, gas and oil engines and of dynamos are well represented. Table 4 shows the predominance of water-driven units in the smallest stations rapidly yielding place to a majority of steam engines in the larger undertakings. The predominance of gas engines in group (e) is due to the fact that the Walthamstow station is here included—see also below.

TABLE IV.—NUMBERS OF PRIME MOVERS IN USE

Station Kw. Range	NUMBER OF				
	Steam Engines	Water Wheels or Turbines	Gas Engines	Oil Engines	Total No. of Sets
(a) 0/100	6	8	5	2	21
(b) 100/250	13	9	5	5	32
(c) 250/500	18	5	7	5	35
(d) 500/1000	43	1	9	9	62
(e) 1000/2500	7	—	14	—	21
Totals	87	23	40	21	171

The advantages of producer gas plant in small stations are undoubtedly considerable, but it is questionable whether such equipment should be installed if the station is likely to extend greatly within 5 to 10 years of its inauguration. A case in point is that of Walthamstow. This station was opened in September, 1901, with an equipment of four 115-hp. and three 250-hp. Dowson gas-driven sets, all supplying an ordinary lighting and power load. In 1905 three 250-hp. sets were added to cope with the increased lighting load, and an equal number were installed to supply a light railway scheme. All these engines are of the 3-cylinder Westinghouse vertical single-acting type, the larger units having cylinder diameters of 20 inches and strokes of 22 inches; 2 to 9 foot flywheels per engine and overload capacity 25 per cent. There was thus, in 1905, 2,710-hp. of Dowson plant at work, but since that date there have been added two 300 kw. Belliss-Siemens units, and in September, 1910, a 1,000 kw. mixed pressure steam turbine driving two 500 kw. generators in tandem. The 13 gas engines and 8 producers are still in service, but their replacement, probably by steam turbines, can only be a matter of time, and it is open to question whether the installation of larger steam driven units in the first place would not have been preferable—it being certain in this case that a vast demand would utimately have to be supplied.

RECENT DEVELOPMENTS AND FUTURE PROSPECTS.

The practicability of the gas turbine has been disputed and asserted for quite a number of years past. There can be little doubt that this class of prime mover will ultimately become common. Recent reports state that Brown, Boveri & Co. have gas turbines of 300 to 500 hp. output in satisfactory operation and units of 1,000-hp. under trial. The Marconnet gas producer claims to burn coal dust of any quality (if finely ground and carried in suspension by air) at the rate of 100 to 160 pounds per square foot of producer section, the ash content of the fuel being run off, from time to time, as a molten slag. Producer units of 1,000 to 5,000 hp. capacity are also claimed as possible. From the Continent comes a suggestion to use sewer gas (which undoubtedly has a certain low calorific value) in internal combustion engines. In considering these and similar startling proposals a reasonable reserve must, of course, be maintained, but it is well to remember that the revolutionary suggestion of yesterday is often the accomplished fact of tomorrow.

Suction gas producers burning peat are in successful operation in several parts of Germany (Osnabruck is supplied from a peat-producer plant 17.5 miles away on the moors). A new peat producer introduced by the Gorlitz Machine Works is claimed to enable delivery at the switchboard at 0.14 cents per kw. hr. (peat being at 90 cents per ton. In small stations suction gas plants and Diesel engines have already established a reputation, and in future competition must lie between gas and oil in such cases, steam being usually out of the question. Every year raises the limiting capacity at which steam plant is the more economical. Diesel engines of 800 to 1,000 hp. are already in operation and the makers announce that they are prepared to build 4,000-hp. units. Coke oven and blast furnace gas engines of 2,000 to 3,000 hp. no longer seem remarkable. The lately evolved vertical multi-cylinder (in tandem pairs) engines of 1,000 to 1,500 hp., built by the National Gas Engine Co., for operation on produrer or coke or blast furnace gas are noteworthy. Of special interest are two 1,000-hp. and one 750-hp. engines of this type (8 and 6 cylinders respectively), designed for producer and similar gases, but actually running on rich town gas in the private central station of the South Suburban Gas Co., London, in the Crystal Palace Exhibition Grounds. These engines are the largest yet running on town gas in this country, and their operation is perfectly satisfactory.

Nowhere in the British Isles can large central stations ever depend on water power, but there is considerable possibility of small village and rural distribution schemes being erected on this basis, particularly in Ireland and certain parts of Scotland and Wales. Small water-driven stations require a minimum of attendance and upkeep, skilled or otherwise, and, providing the capital cost of the station can be kept down, as should readily be possible in such small equipments, there is every prospect of satisfactory cheap electric supply being afforded to large numbers of country consumers. Bare overhead aluminum overhead lines, metallic filament lamps and the cheap and efficient transformer and motor equipment now on the market all further this possibility and high hopes are substantiated by the extraordinary success of such a scheme recently inaugurated at Valcanville, France, where power is distributed from a 15 to 20 hp. stream (passing 1,000 litres per second with a fall of 1.7 to 2.0 metres at the station) to isloated houses and hamlets and to the town of Barfleur 7 kms. away. Aluminum wires are almost exclusively used and the bulk of the transmission lines run across ploughed fields. Transformers are fitted on each consumer's house, unless a sufficient number of consumers lie close enough together to justify local low tension lines. Long distance transmission is at 5,000 volts, but every consumer is supplied at 110 volts for lighting purposes. The average distance between consumers is 200 metres. An isolated farm 1,400 metres from the power house is supplied by a special line; there are villages at 1,400 and 1,700 meters, respectively, from the station and distributing centers on the main h.t. line at 3, 5 and 7 kms. from the power house. The supply afforded is so cheap and satisfactory that paraffin lamps are being displaced wholesale and a number of farmers are using electric lamps in their stables. Such results, under by no means favorable conditions, augur well for the future of small water power rural schemes elsewhere.

Mineral Output of the World.

Consul General John L. Griffiths, London, England, reports that the number of persons employed in the mines and quarries of the world in 1909 was 6,000,000, of whom 1,250,000 were employed on the British Isles and 1,000,000 in other parts of the British Empire.

The world production of coal was 1,113,000,000 metric tons (metric ton = 2,204.6 pounds), of which the British Isles produced 268,000,000 tons and the rest of the British Empire 37,000,000, the United States 418,000,000 tons, and the German Empire 217,000,000 tons.

The world output of copper was 800,000 tons; of fine gold, 600,000 kilos (kilo = 2.2046 pounds), of which the Transvaal furnished 226,000 kilos; of iron, 58,000,000 tons, of which 26,000,000 tons were in the United States; lead, 1,000,000 tons; petroleum, 40,000,000 tons, of which 24,000,000 tons were American; salt, 17,000,000 tons; fine silver, 6,000,000 kilos, of which 2,250,000 kilos were Mexican; tin, 116,000 tons; and zinc, 885,000 tons.

The total value of the above production is estimated at $4,209,522,500, the value of the coal output being $1,946,600,000. The output of gold is said to have had a value of $455,830,455.

Control Apparatus for D C Motors

(*Contributed Exclusively to* Southern Electrician.)

BY GEORGE J. KIRCHGASSER.

MOTOR controllers or controlling devices include such common apparatus as starting rheostats or starting "boxes" (so called because of the box-like shape of the first types) speed regulating rheostats or regulators and apparatus such as controllers on street cars, cranes, etc., usually consisting of an enclosed drum operated by a handle at the top. Besides these common devices there are automatic starters and controllers used for starting, for varying the speed of and for stopping electric motors. It would be impossible, except in a volume of several thousand pages, to describe more than a few of the various distinctive types and styles of motor controlling apparatus. For every motor application, except where the horsepower is very small (1-4 or less) at least a starting rheostat is required. For alternating current squirrel cage motors and some types of single phase motors, starting apparatus is often not necessary, even where the capacities are 2, 5 and sometimes 10 horsepower.

When the development of the electric motor had reached a point where some practical commercial applications were made (in the early 80's of the last century) it was found that in cases where the motor was not most efficient and had low armature resistance, that a very great current inrush occurred when the motor was connected to the lines by closing the knife switch. And when the armature was built with a high resistance the current at starting was reduced, but as this resistance was always in circuit during running, the

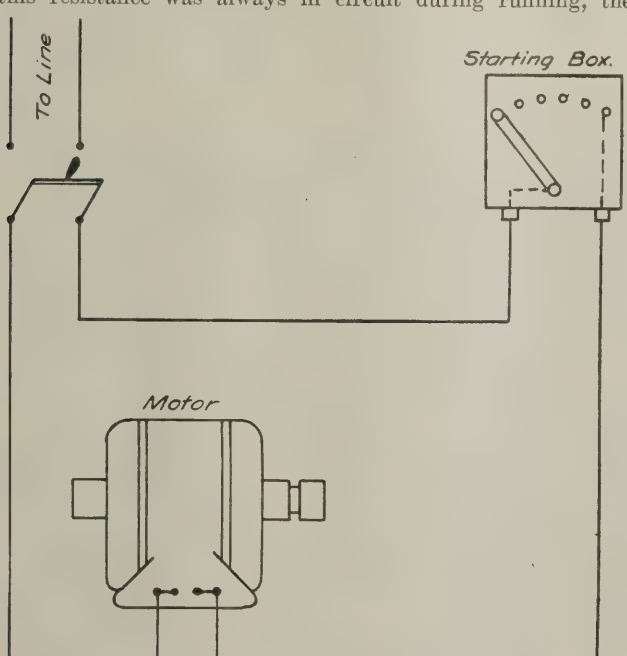


Fig. 1. Diagram of Early Starting Box.

running operation was not efficient for if the load varied the speed was also affected. The high resistance armature motor therefore while preventing abnormal currents at starting, was inefficient at other periods of operation, and had no self-regulating speed feature. The low resistance armature motor (shunt type) which followed the above type, did not check the current at starting but had the advantage of being able to run at about constant speed even though the load that the motor was driving varied considerably. It is of course understood that the reason for the current inrush at starting is because of the fact that before the armature conductors are set in motion there is no counter electromotive force to check the flow of current. It is only after the armature speeds up that the counter electromotive force is generated and after this the current in the armature conductors is automatically regulated.

To allow proper starting with graded accèleration, the low resistance armature motor was provided with a starting "box" to be connected in circuit with the armature as shown in Fig. 1. This consisted of several steps of resistance and a lever which could be moved over contacts connected to this resistance. On starting up, the knife switch was first closed and then the lever of the starting box moved from the left hand side to the right hand side cutting out resistance as the motor came up to speed. In the extreme right hand position, no resistance was in circuit and the motor was connected directly to the line. When shutting down the operator had to open the switch and move the lever back by hand to the starting position. Failure to move the lever back resulted in a current inrush and blowing of fuses, etc., when the next start was made and the knife switch closed. This frequently happened and was a serious obstacle in introducing motor power.

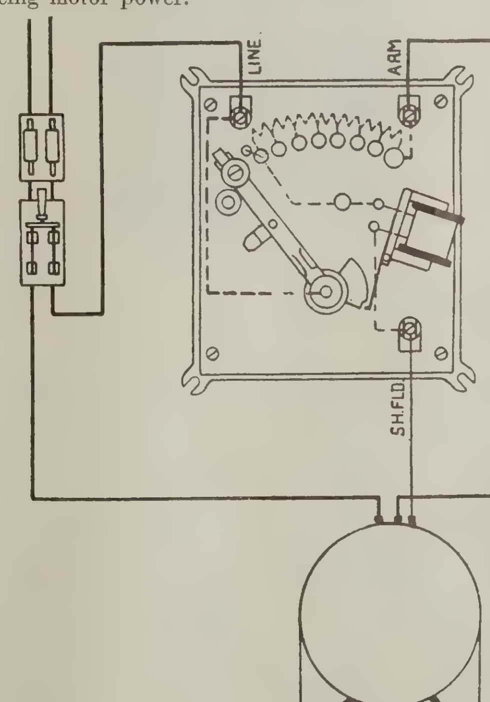


Fig. 2. Connections for Blades Starter.

Besides this the lever could be left on any intermediate position and the resistance, instead of being in circuit only during the short period of starting was left in during the time the motor was running with the result that it burned out. This added a fire hazard as well as being poor from an engineering standpoint. A third disadvantage of a starter, which consisted of resistance to be connected only in

the armature circuit, was that in case the shunt field circuit was broken (much more liable in the early days than now) the motor would race, due to field weakening, and no means for shutting the motor down in a case like this was provided except by the operator.

With the starting "box" described, it was thus necessary to provide a careful attendant for every motor. The re-establishment of the current supply after an interruption of the current left the motor to be subjected to a heavy current as, unless the attendant was there to push back the lever of the starting box from the "on" position, with no resistance in circuit, to the position with resistance in, there was nothing to check the current inrush and prevent the sudden racking starting of the motor. The sudden drop in voltage, which occurred when the generators and transmission systems were yet unreliable, slowed up the motor and the return of full voltage caused a heavy current to flow again. All of these dangers were a serious menace to the commercial application of the electric motor and it is doubtful if any of the pioneer electrical engineers of that period, in his most enthusiastic moments, could have thought that in less than 30 years the electric motor would be so universally used.

In the early part of 1890 a patent was issued to Mr. H. Blades covering a starting device for direct current shunt motors (no A. C. motors were then used) which overcame the dangers of using a motor with the resistance box as described above. Mr. Blades' starter, the first of the subsequently large number of starters and regulators, represented a very important step in the adaptation of electric motors for industrial and commercial use. The diagram, Fig. 2, shows the connections for the Blades patent starter and Fig. 3 illustrates the present day motor starter for direct current motors built on the same principle. Reference to the diagram shows a resistance divided into steps which is in series with the armature of the motor when the contact arm is in the "off" position. By moving the contact lever to the "on" position the resistance is cut out entirely from the armature circuit and a magnet retains the contact lever in this position. This magnet is connected in series with the shunt field of the motor, is not therefore effected by varying currents flowing in the armature circuit (due to varying loads) but is demagnetized when the shunt field circuit is opened. The operating lever is returned by a spring to the "off" position so that when another start is made all the resistance is in the armature circuit and an excessive inrush of current is avoided. The spring also prevents having the lever on an intermediate contact preventing burning out of the resistance.

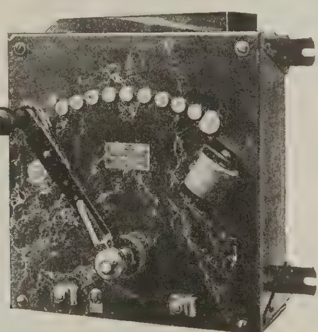


Fig. 3. Appearance of Starter of Bladestype.

The automatic release feature which returns the contact lever to the starting position in case of the blowing of a fuse, interrupting the current supply, or in case the voltage of the line be decreased for a prolonged period, is what made the new starter so much superior to the old starter which required an alert attendant to push the contact lever back to the starting position. Another advantage of the automatic or "no-voltage" release of the new starter was, that if the voltage of the supply dropped a little for a few seconds the motor, although slowed down a trifle, would not be disconnected as the contact lever was not immediately released to the "off" position. As the shunt field current varies only slightly under such conditions the magnet holds the lever in place and only a prolonged period of decreased supply voltage decreases the magnetism sufficiently to release the contact lever. Placing the retaining magnet in series with the shunt field of the motor was the proper solution and at once caused those attempting to place a releasing mechanism in series with the armature circuit for this class of starter to abandon their work.

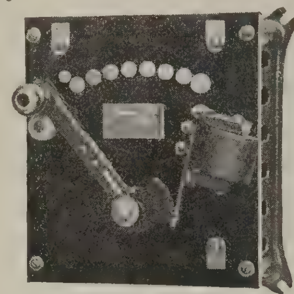


Fig. 4. The Panel Type of Regulator.

In the first motor applications, the motor was simply substituted to drive the line shafting in place of the steam engine. The shafting was later divided up and driven by separate motors but even for these applications only a means for properly accelerating from stand still to full speed was required. For this purpose the motor starter was satisfactory. But as the number of motors installed increased, the designing engineers improved the motors, and motors for individual drive began to be used. For this work means for varying the motor's speed became desirable. At the present time speed regulators and controllers for varying the speed of motors of every size and for practically every possible application have been standardized. The simplest type of regulator is the panel type illustrated in Fig. 4, which is similar to a starting rheostat except that its resistance is of greater capacity so as to be able to carry the full load current of the motor continuously at any speed step. The contact arm of the starter has a spring which prevents leaving the arm on any of the contact buttons, but as the resistance of the regulator is of greater capacity, provision is made for allowing the contact arm to be passed backward and forward, and left on any intermediate point.

However the "no-voltage" release is so connected that the spring pawl which engages the teeth in the fan tail of the contact arm is pulled out of engagement allowing the contact arm to return to the "off" position in case of interruption of current supply, blowing of a fuse or prolonged drop in the voltage of the supply. The regulator of the type shown is used to insert resistance in the armature circuit, thereby reducing the speed from normal to usually one half speed with various steps between.

The speed of ordinary shunt wound and compound wound direct current motors may be varied by inserting

resistance in the armature circuit of the motor or in circuit with the shunt field. Standard regulators are made for both of these purposes, and also for combining the two general methods. Resistance inserted in the armature circuit reduces the speed below normal, an amount depending upon the amount of resistance in circuit. A reduction to one-half speed is usually provided, as when a greater reduction (75 per cent) is attempted a silght increase in the load on the motor is apt to stall it.

Regulators for decreasing the speed below normal, by means of armature resistance, are especially suited for use with motors driving ventilating fans and similar machines in which the torque decreases as the speed decreases. The power required when running at slow speed is less than at full speed. Regulators used in this connection have the capacity of their resistance tapered in proportion to the amount of resistance inserted, being about one-half the normal full load current capacity when all resistance is in circuit, that is when the operating contact arm is on the first left hand contact. As the contact arm is moved to the right, steps of resistance are cut out and the speed increases up to full normal speed, when the contact lever is in the extreme right hand position with no resistance in circuit.

As stated above the armature resistance method is suited for fan control because the current flowing in the motor armature is less at speeds below normal than at full speed and therefore the amount of power dissipated in the resistance is not as great as with constant-torque machines, such as hydraulic pumps, machine tools, etc., which require practically the same amount of current at half speed as at full speed. This duty is referred to as "machine duty." In regulators for this kind of service the resistance is designed for equal current carrying capacity on each step, the amount of resistance being enough to cause a 50 per cent drop in voltage with normal current flowing and all resistance in circuit. The resistance of this type of regulator is relatively higher in ampere capacity and

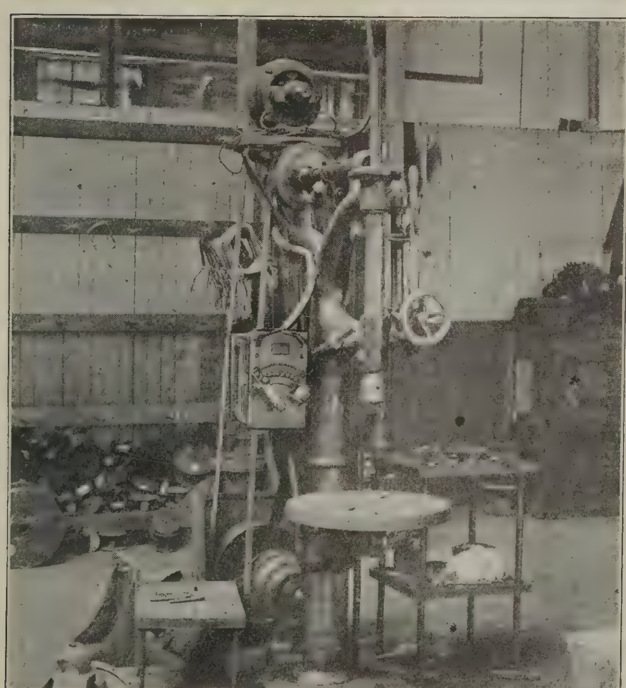


FIG. 5. COMBINATION STARTER AND REGULATOR FOR MOTOR-DRIVEN DRILL PRESS.

lower in ohms than the "fan" duty regulator. It is, therefore, necessary to know the kind of service for which the regulator is to be used before selecting it. The resistance of a "fan" duty regulator used on a constant torque machine would become overheated and probably be burned out, while the "machine" duty regulator if used to regulate a fan would not give a 50 per cent speed reduction.

Standard shunt-wound motors of today will inherently regulate to run at approximately constant speed even though the load being driven is varied. This desirable regulating characteristic is not maintained if resistance is inserted in circuit with the armature as is the case with the armature type regulators described above and illustrated in Fig. 4. This is because a change in load causes a change in the voltage drop in the armature and therefore the voltage being applied to the motor brushes varies which varies the speed. Of course, the contact lever can be moved forward or backward to again obtain the speed desired. Another objection to obtaining speed variation by reducing the voltage at the brushes through inserting resistance in series with the armature is that considerable energy is wasted to secure speed reduction and the range of speed variation is not very great.

Where, as in the case of the ventilating fan or similar machine, the load does not change and where the current at speeds below normal becomes less, speed regulation by armature resistance is satisfactory and not very wasteful of energy. In other cases of machines of the constant torque type the use of the armature resistance regulator may be justified if the machine is run practically all the time at full speed. The cost of installation will be low, as any motor of standard design can be used.

Inserting resistance in series with the field circuit of a motor reduces the current, weakens the field and causes the motor to run at a higher speed. A regulator for giving various speed steps above the normal speed is shown mounted on a motor-driven drill press in Fig. 5. By use of this, the motor is first brought up to speed as with an ordinary motor starter then part of the double lever can be moved backward or forward over the contact buttons which will give about a dozen speed steps. As the shunt field current of a motor is small, the resistance required for such a regulator is less than with the armature resistance regulator and very little energy is dissipated in the resistance. Provision is made to prevent starting the motor with weakened field. When the contact lever returns to the starting position, no resistance is connected in circuit with the shunt field and none can be inserted until the motor has been brought up to speed.

Speed variation by shunt field resistance does not effect the self-regulating feature of the shunt motor and it is not wasteful of current, all current taken from the line being transformed into power. For wide speed variations, motors specially designed for the work are required as with the standard motor for ordinary use a speed increase of only about 10 to 15 per cent above normal is the safe maximum. Motors can however, be obtained for greater speed increases.

Where a wide variation in speed is desired from a value below normal to above, a regulator which combines the two methods, that is, reduces the speed below normal by armature resistance and increases above normal by shunt field resistance, may be used. Such a regulator will reduce the speed of a 1,200 rpm motor to 600 rpm and increase it to 1,500 rpm. Fig. 6 shows a regulator which is

designed to reduce the motor speed to one-half normal and to increase it to two times normal, or a 4 to 1 ratio.

In the printing industry there are a great variety of regulators and controllers for the various motor-driven machines. In the first place there are many types of presses from the large octuple newspaper press to the small job press, besides folders, stitchers, cutters, punches, etc. The illustration, Fig. 7, shows a regulator mounted on an offset press which provides for obtaining speed reduction to one half speed and speed increases above normal of 25 per cent. With small job presses this type of regulator is

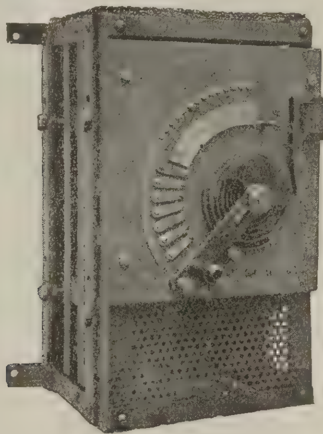


Fig. 6. A Regulator Designed for 4 to 1 Speed Ratio.

sometimes used as well as the reversing type. Carpenter type controllers are widely used in printing establishments for the control of flat-bed presses such as are used for a large part of commercial printed matter. Although alike in external appearance they are made in a great number of types reversible and non-reversible. As can be seen by referring to Fig. 8, the operating lever extends from the enclosing case at the top and movements backward or forward give the speed changes desired. Within the past year a Carpenter type controller for polyphase motors also was put on the market.

Drum type controllers are also used with flat-bed printing presses, and are made in both direct and alternating curent types. A revolving cylinder operated by the handle at the top makes contacts with stationary fingers and these give the various speed steps required. The illustration Fig. 9, shows one of 7 Miehle flat-bed presses each equipped

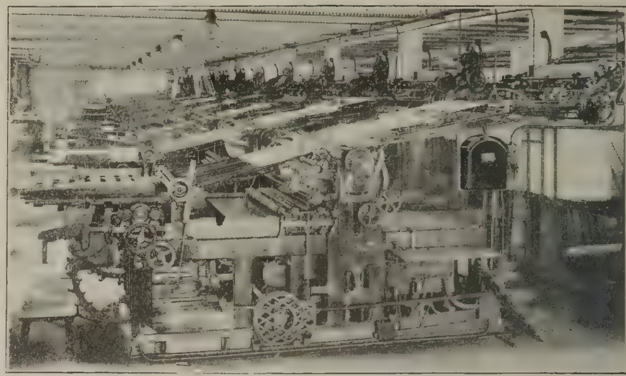


Fig. 8. A Controller for Flat-Bed Presses.

with drum type controllers and individually driven by 5 hp Watson motors in the plant of the Meisenheimer Printing Co., at Milwaukee.

The great development in the newspaper business, which has reached a higher degree in this country than in any other, has made necessary a class of control equipment that makes possible speed, continuous operation and safety. The large deck presses required by the increasing size of the daily newspaper and the many editions printed has created a separate field for the motor manufacturer and controller designer. The Kohler Brothers of Chicago, because of a long period of experience with motor-driven printing plants, perfected automatic control equipments that are successfully operating on a large majority of the large newspaper presses in this country, Europe and South America. The "Kohler" system permits of placing push button stations at one or more places on the press from any of which the starting, "inching," accelerating, and stopping can be controlled. The controller panel is mounted beside or behind the press, or in a gallery some distance away.

Automatic starting of motors is required in some classes of work and self starters or automatic starting rheostats used in this connection are also made in types constantly increasing in number and variety of function. Unless one is in close touch with the controller manufacturer, it is difficult if not impossible to keep posted on the new lines of apparatus and new arrangements which are developed

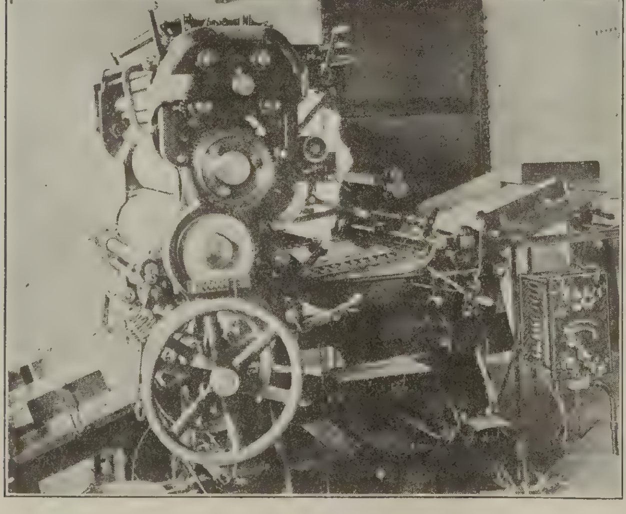


Fig. 7. Regulator for Speed Reduction and Increase on Printing Presses.

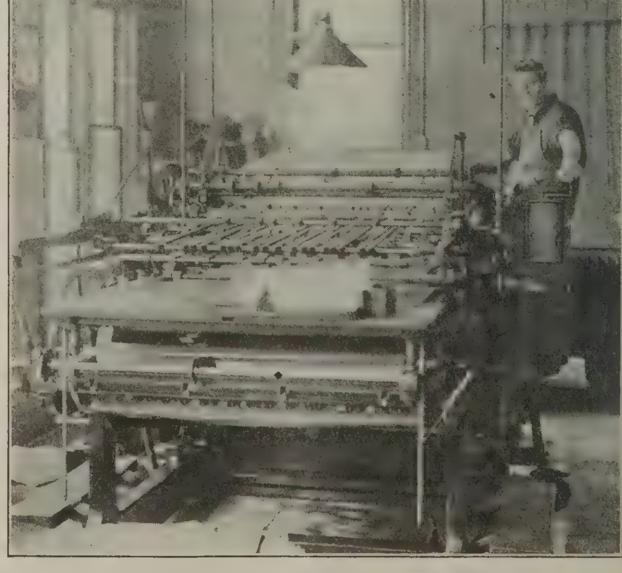


Fig. 9. Drum Type Controller for Flat-Bed Presses.

to meet new requirements. In the dash pot and solenoid type self-starter the solenoid (coil of wire) sucks in its iron plunger when it is energized by the passage of current through it. The rate at which the plunger moves is controlled by the dash pot which can be regulated to accelerate the motor slowly or quickly as desired. In the current relay type of self-starter, separate solenoids cut out separate steps of resistance from the armature circuit and thus brings it up to full speed.

In connection with motor-driven pumps and air compressors the self-starter finds one of its widest fields of usefulness. By means of a switch operated by a copper float in a tank, the circuit to the motor is automatically opened and closed through the self-starter whenever the water in the tank reaches a pre-determined high or low level. The same device may be used in sump pits or wherever there is sufficient change in water level to operate a float switch. In compression tank systems, and when used with air compressors, a pressure gage is substituted for the float switch, the circuit being made and broken as the indicating needle moves back and forth between two fixed points.

In some plants automatic motor starters are installed solely for the purpose of preventing careless employees from starting up the motors too suddenly, but the value of the self-starter consists chiefly in the fact that when combined with suitable auxiliary devices, such as float switches, pressure regulators, limit switches, or even a push button switch, they dispense altogether with the need of employing someone to start and stop the motor at the proper time, or else enable the one charged with this duty to control the motor from a distance.

Without referring to the controllers for elevators, steel mills, coal and ore handling machinery, etc., it can be seen that there are an almost unbelievable number of motor controlling devices. To gain the best results from motor drive, the selection of the particular type of starter or regulator may be of considerable importance and those installing motors should keep in touch with developments in controlling devices.

Engineering and Commercial Features of Direct and Semi-Indirect Lighting.

BY T. W. ROLPH AND J. G. HENNINGER AND S. G. HIBBEN.

A Discussion of Engineering, Comparative Efficiencies, Illumination and Cost of Direct and Semi-Indirect Lighting.

THE subject of direct versus indirect lighting has been discussed and formed the basis for interesting comparisons of well lighted areas at various meetings where good lighting conditions and results were topics of interest. It has however been only recently that absolute data has been available and the results of installations been sufficiently complete and varied to enable a general survey or comparison of the systems. At a meeting of the Illuminating Engineers Society last May, vital information was given out on the engineering considerations and the comparative efficiencies of direct, indirect and semi-indirect lighting, by T. W. Rolph, T. G. Henninger, and S. G. Hibben, from which the following information has been taken.

The illumination received from the majority of lighting systems can properly be treated as made up of two parts, the direct and indirect components. The direct component is that portion of the illumination which is produced by light reflected from a ceiling or walls or both before being received on the plane of illumination. Some lighting systems have one component only, that is, they are totally direct or totally indirect. Obviously, the direct component is more efficiently obtained than the indirect. Until the recent more general introduction of indirect lighting, the physiological value of the indirect component of a system was but vaguely realized and the principal engineering aim in practically all lighting systems was to increase the direct component, thereby increasing the illumination efficiency.

There are, however, certain distinct advantages which a high indirect component of the illumination possesses compared with a high direct component. In an appreciable number of lighting propositions, these advantages will justify the comparatively low efficiency of indirect or semi-indirect lighting.

ADVANTAGES OF A HIGH INDIRECT COMPONENT.

The advantages of a high indirect component are due to the diffusion of the light comprising the indirect component. Diffusion might be termed multi-directional character of light. In other words, with diffused light, the illumination at any point is produced by light-rays coming from many different directions rather than from a single direction. It is apparent that the use of a large area like the ceiling for a secondary light-source necessarily results in multi-directional or diffused light. The principal advantages, which are produced by the diffusion of a high indirect component are: low degree of specular or regular reflection from surfaces worked on; absence of deep and sharply defined shadows; low candle-power and low intrinsic brilliancy of light-giving areas.

Absence of deep and sharply defined shadows is obtained by the multi-directional character of the light composing a high indirect component of the lighting system. It is well to make a distinction here between shadows and shaded areas. Shaded areas may be defined as shadows with indiscernable edges. Shaded areas are always in evidence. Shadows, in the narrow meaning of the word, may be entirely eliminated. A sharp shadow may be very objectionable while a shaded area of the same maximum depth would not be. The value of lack of deep shadows is self-evident. It varies with different classes of service. In drafting, shadowless illumination is the ideal. In offices, shadows are less objectionable, faint shadows are really desirable to aid in giving perspective to objects. In residences, theatres, etc., some shadow is very desirable.

Low candle-power and low intrinsic brilliancy of light-giving areas result from the nature of diffused light. Its multi-directional character precludes the possibility of any appreciable amount coming from a single point or a small area. Of course, the direct component may nullify this, but all the light which makes up the indirect component is diffused. Depression of visual function and ocular discomfort are both in evidence to a greater or less degree when a light-giving area of appreciable candle-power or intrinsic brilliancy is in the field of vision or is in a position such as to come into the field of vision even occasionally.

Summing up the advantages of the indirect component of lighting systems one may say that the diffusion or multi-directional character of the light tends to decrease glare due to specular reflection from surfaces worked on; it tends to decrease the depth of shadows and to eliminate their sharp edges; and it tends to protect the eye from brilliant light-giving areas. To what extent these advantages are nullified by a direct component will be discussed further on in this article, when these advantages will be considered in a more quantitive manner.

DISADVANTAGES OF A HIGH INDIRECT COMPONENT.

Having considered the advantages of the indirect component compared with the direct, the disadvantages will be taken up. These are briefly: low efficiency and rapid depreciation due to dirt; light on walls, which may cause depression of visual function; bright ceiling, which may cause undesirable appearance and lack of perspective, due to lack of shadows. Of these disadvantages, the first named is by far the most important. The efficiency of obtaining the indirect component considering the light after it has left the unit may be as low as 10 per cent. of the efficiency in obtaining the direct component (which is, of course, 100 per cent, considering efficiency back to the light-unit only). It may run as high as 50 per cent. in exceptional cases. The disadvantage of low efficiency and rapid depreciation cannot be overcome. Proper design will do much toward lessening them, but in any lighting system in which the indirect component of the illumination is high, the advantages of that component should be great enough to justify the comparatively high cost of operation and maintenance.

Too much light on the wall will cause depression of visual function. When the indirect component of a system is high, the walls should be dark in color. This disadvantage will then be nullified but this is accompanied by a reduction in illumination efficiency. The net efficiency may not be reduced when the walls are darkened, however, as the increase in visual efficiency may more than make up for the decrease in illumination efficiency.

The brightness of the ceiling increases as the size of the indirect component of the illumination increases. In the case of totally indirect lighting, there is usually a decided contrast in brilliancy between the dark light-unit and the bright ceiling. This is somewhat objectionable from the appearance standpoint. Appearance considerations also render it desirable to avoid, as far as possible, a very bright ceiling or a spotted effect on the ceiling, due to great variation in brightness.

Perspective very largely disappears in shadowless illumation. In a few classes of lighting—drafting for example—this is desirable. In most classes of lighting it is undesirable. Entire absence of shadow is very rarely obtained, however. Even in totally indirect lighting, the light-giving area of the ceiling is so restricted that some shadow or shaded area is usually in evidence. Still, it is quite possible to have the diffusion too great and the resulting loss in perspective more than the gain in other respects warrants.

It is apparent that by proper design, all the disadvantages of high indirect component of the illumination can be overcome, to a large degree, except the disadvantage of low efficiency. The latter obviously in no way detracts from the desirable illumination features; it merely makes them more expensive.

FACTORS AFFECTING THE PROPORTIONS OF DIRECT AND INDIRECT COMPONENTS.

The illumination advantages, accompanying the use of a relatively high indirect component of illumination has led to considerable use of lighting systems in which there is no direct component and more recently to systems in which the direct component is present, although small. It is desirable to determine what proportions of direct and indirect components are best, in order to obtain to their fullest extent and most efficiently the advantages of a high indirect component. Other things being equal, the greater the direct component, the higher the efficiency; yet the direct component may be increased to a value such that the advantages of the indirect component are largely nullified. If that point is reached, the sacrifice in efficiency to obtain a high indirect component is unwarranted. To justify the comparatively low efficiency of a high indirect component, the proportions of direct and indirect light should be such that the advantages of the indirect component will be obtained to the most desirable degree and the disadvantages as little as possible.

The important questions are: To what extent is diffusion or multi-directional light desirable, first, from the standpoint of extent of specular reflection allowed by good practice? and, secondly, what depth and sharpness of shadow should be allowed by good practice? What brightness of bowl is desirable from the standpoint of eye-pro-protection and contrast? Finally, what percentage of direct component will give these?

Diffusion is the most important consideration. As has been already pointed out, one of the principal reasons for diffusion is the specular reflecting character of surfaces commonly worked on. The surface which may be taken as the extreme is the half-tone paper of magazines. Such surfaces are in common use and likely to continue so for many years to come. A fair criterion of the diffusion desirable is that it shall be such as to allow comfortable reading from half-tone paper in any position. Any uni-directional light will give glare effect in some position with such paper. This criterion will therefore dictate that the brilliancy of the unit should be no greater than the maximum brilliancy of the ceiling, assuming the area of maximum brilliancy is great enough to cause no appreciable specular reflection. Any light emitted by the unit will then be practically of the same intensity as the light coming from a similar nearby area of the ceiling. The two will merge and there will be no glare from regular reflection due to the direct component of the illumination. Great accuracy is not necessary in de-

termining what per cent direct component will give this degree of brilliancy. Indeed, great accuracy is impossible, since ceiling brightness will vary in practice with the color of the ceiling, the distribution from the unit and the distance of the unit below the ceiling; while the brilliancy of the unit will vary with its size, assuming the direct component to be constant. It is profitable, however, to consider an average case.

In the illumination tests of Messrs. Sweet and Doane, the semi-indirect unit, comprising a prismatic reflector and an art glass envelope, had a brilliancy only slightly lower than the maximum brilliancy of the ceiling when the latter was white. The prismatic reflector was of the focusing type and the brilliancy of the ceiling would therefore be considerably lower with a wider distribution, which is more generally used and more desirable from the standpoint of obtaining diffused illumination. It is highly probable therefore, that to obtain no specular reflection on working surfaces, due to direct light, the percentage of direct light should be as low or lower than in the unit referred to. With this unit, the proportions of the illumination received directly and indirectly, with white ceiling and white, medium and dark walls, respectively, was in the tests referred to, 11 per cent and 89 per cent; 13 per cent and 87 per cent; 14 per cent and 86 per cent. It seems reasonable to assume, therefore, that the elimination of specular reflection from working surfaces will be obtained to the most desirable degree if the direct component of the illumination is no greater than 12 per cent. Obviously, the direct component may drop to any value below 12 per cent and the results will be as good from the standpoint of eliminating specular reflection.

The question of sharpness of shadow and depth of shadow permissible has almost the same degree of importance as the question of specular reflection. Shadows, even though faint, should not be sharp. Any shadow caused by the direct light from the unit will be fairly sharp, the degree of sharpness depending on the size of the unit. It has been found that a sharp shadow of 20 per cent on working surfaces is about the limit of good practice for illumination in which any close visual work is to be performed. Further tests have shown that for direct lighting a shadow of 10 per cent on work is about the lowest to be annoying. A 40 per cent shadow was found to be the absolute limit permissible by good practice.

In order to obtain the best results from the shadow standpoint, it seems desirable to have no sharp shadows of greater density than 15 per cent. on working surfaces. This is approximately the limiting density at which contrast might produce depression of visual function. It should be low enough for good results in office work, although for drafting a 10 per cent shadow limit on working surfaces would probably be better. Other classes of lighting might not require as low a shadow limit for best results. On the whole, however, a 15 per cent sharp shadow is probably a desirable average high limit for semi-indirect lighting. The low limit should be determined largely by the degree of shadow necessary to obtain perspective. From the shadow tests, reported above, it is evident that this limit is in the neighborhood of 10 per cent. The most desirable sharp shadow is probably, therefore, from 10 to 15 per cent. This means that the direct component of the illumination should be (from the shadow standpoint) from 10 to 15 per cent of the total illumination, since the direct light will cast a shadow with fairly sharp edges.

The question of eye protection, demands that the intrinsic brilliancy and the candle-power in the direction of the eye be low. The intrinsic brilliancy of the ceiling in indirect and semi-indirect systems is sometimes none too low for best eye-protection. It therefore seems that a fair criterion for the limiting brilliancy of the unit from the standpoint of best eye-protection is the criterion adopted for elimination of specular reflection, *i. e.,* that the unit have no greater brightness than the ceiling. While this specification cannot be considered as rigid, it is nevertheless approximately what is desirable to work to.

CONCLUSIONS REGARDING THE DIRECT COMPONENT.

From the foregoing text, the following conclusions regarding the direct component of the illumination may be deduced: (1) For the best degree of elimination of specular reflection on working surfaces it should be little greater than 12 per cent. (2) For best shadow values it should be from 10 per cent to 15 per cent. (3) For best degree of eye-protection it should be little greater than 12 per cent.

These values cannot be taken as exact, since the present state of our knowledge of the subject does not permit of exact determinations. At the present time, however, one may say with reasonable certainty that in order to obtain, to the most desirable degree, the advantages of a high indirect component of the illumination, the direct component should be from 10 per cent to 15 per cent of the total illumination. Departure from these values will probably lessen the advantages of this class of lighting. If the direct component of the illumination is decreased below 10 per cent, there is apt to be loss of perspective and, if it goes as low as zero, undesirable appearance factors are likely to be introduced. If the direct component of the illumination is increased beyond 15 per cent, the advantages of the indirect component are apt to be seriously reduced. There is undoubtedly some value, not far beyond 15 per cent, at which the illumination advantages of a high indirect component are so seriously reduced that the comparative inefficiency of this class of lighting is no longer justified mainly from the esthetic standpoint—a difficult task, considering the variety of attractive direct-lighting units available.

There are, of course, a great number of lighting propositions, for which the diffusion and consequent illumination advantages of a high indirect component are quite unnecessary. Probably for the great majority of installations the higher cost of indirect or semi-indirect lighting is not warranted on engineering grounds. In a few classes of service—drafting rooms and picture galleries, for example—the diffusion is, undoubtedly, of sufficient value to warrant the high cost. In any case of lighting, however, a well-designed direct system is preferable, on engineering grounds, to a semi-indirect system in which the direct component is great enough to seriously reduce the illumination advantages of the indirect component.

COMPARATIVE EFFICIENCIES OF DIRECT, INDIRECT AND SEMI-INDIRECT LIGHTING.

By Mr. Henninger.

Consider these systems from the standpoint of efficiency alone, the average taken from the large number of tests show that under favorable conditions an indirect system may be counted on for about two lumens per watt. Small rooms with light walls and ceilings will sometimes show an efficiency as high as 2.5 lumens per watt, while in large rooms with high ceilings, the efficiency may come down to 1.5 lumens per watt and perhaps less.

An extremely interesting test to determine the relative efficiency of an indirect versus a direct system of lighting has just been completed by the National Electric Lamp Association. The room in which the test was conducted is 19 ft. by 39 ft. 7 in. with a 12 ft. 2 in. ceiling. The walls are light yellow and the ceiling flat white. The lighting was provided in one case by eight 150-watt X-Ray tungsten units uniformly spaced in two rows of four each; while in the other, eight 150-watt tungsten lamps equipped with prismatic reflectors were used in the same outlets. Conditions were made as nearly uniform as possible so that the results would be comparable. Another interesting feature of the test is that both clear and bowl frosted lamps were used.

	Direct illumination		Indirect illumination	
	Clear	B. F.	Clear	B. F.
Average intensity of illumination	6.39	5.63	2.77	2.40
Effective lumens per watt	4.00	3.52	1.73	1.51
Relative per cent based on clear lamp, direct system	100.0	88.0	43.3	37.7

Another test conducted on an indirect lighting unit in a small room afforded some interesting information. The dimensions of the room were as follows: length 9 ft. 10 in.; width, 8 ft.; ceiling height, 8 ft. 3 in.; unit at standard position was 12 in. from ceiling.

	Effective lumens per watt
Black walls, white ceiling	1.66
White walls, white ceiling	2.43

Maximum variation reduced from 70 to 47% by white ceiling.

Illumination measurements taken with the unit at various distances from ceiling gave the following results. The farther from the ceiling, a little more uniform was the illumination. The best hanging height is plainly evident from these data.

	1 ft.	1 ft. 6 in.	2 ft.	3 ft.
Extreme variation above average, per cent	21.5	19.3	22.7	21.4
Extreme variation below average, per cent	22.0	21.1	20.2	17.6
Effective lumens per watt	2.65	2.90	2.69	2.66

A third test was conducted in a barber shop lighted by means of a semi-indirect system. The shop was 36. ft. by 18 ft with a 12.6 ft. ceiling. The lighting equipment consisted of three 4-lamp fixtures uniformly spaced along the center of the room. Each fixture was equipped with four 100-watt lamps fitted with inverted translucent glass reflectors. There was a wainscot of white marble about 36 in. high along two sides and across the end of the room, while above this was a line of mirrors reaching to about 7 ft. above the floor. The remainder of the walls and ceiling was tinted a light buff. The test results were as follows:

	Foot candles
Average intensity of illumination	5.78
Watts per square foot	1.875
Lumens per watt	3.08

Another interesting series of tests was conducted, using prismatic glassware and tungsten lamps. The room was 18 ft. 10 in. by 23 ft. with a beamed ceiling 13 ft. 10 in.—beams 15 in. by 5-5 in. on four-foot centers. The walls were of natural wood finish while the ceiling was painted with "factory white."

In the first case the units were hung in their normal positions and illumination measurements taken. Then the units were simply turned upside down and suspended by cords at a distance of 4 ft. from the ceiling which happened to be about the same height at which the units were previously hung. Lastly, the reflectors were surrounded by a cone of bristol-board, the inside of which had been painted a dead black, the idea being to determine exactly what portion of the illumination obtained with the inverted system was due to reflection from the ceiling. The results are tabulated below.

	Effective lumens per watt	Maximum variation per cent	Relative efficiency per cent of direct system
Totally indirect	1.027	78	33.75
Direct	3.04	55	100.0
Semi-direct	1.54	44	50.6

Efficiency is unquestionably in favor of semi-indirect illumination as compared with indirect illumination; but how about relative ability to see well, etc.? A drafting room, for instance, can be lighted remarkably well with indirect illumination. There are no bothersome shadows and the workmen are comfortable. On the other hand, in a certain drafting room in which the system is direct overhead, there are two 60-watt bowl frosted tungsten lamps fitted with satin-finished prismatic reflectors placed above and in front of each drafting table. The reflectors are good diffusers as well as reflectors. The ceilings are light so that all in all the installation is eminently satisfactory. In another drafting office four-light semi-indirect lighting fixtures are being used with great success.

The consensus of opinion now is that there is but slight difference between the intensity required to see well under the two forms of illumination, viz., direct and indirect, provided the installations were equally well made. Diffusion seemed to be the determining factor. It is agreed, however, that there is need of much more comprehensive work along that line.

SEMI-INDIRECT LIGHTING.

By Mr. Hibben.

Indirect lighting may be divided roughly into two classes: opaque units which deliver all of their reflected light directly to the ceiling or upwards to a redirecting diffusing surface; and units which throw some light up and in addition to doing this also transmit more or less light

directly through their sides and bottom to the surface or objects to be illuminated. The first class should be known as the strictly indirect system. The second system has of late taken the title semi-indirect. For convenience consider any type of unit that is not opaque but of some translucency as belonging to the semi-indirect type—granting of course that such units have the form of a fixture that depends appreciably upon the upward projected component for its operation. Obviously there may be differing degrees of translucency of the semi-indirect units, but these remarks deal primarily with a general type having a goodly proportion of transmitted light; the advisability of a semi-direct lighting system; the comparison between direct and semi-indirect lighting costs; and the artistic side of the subject, briefly; it presents illustrations of several lighting units, and touches upon the various effects of the different ratios of transmitted and reflected light flux as these ratios affect illumination results.

The most nearly complete short consideration of semi-indirect lighting can be made by again dividing the subject into corelated parts, consisting of the distribution of illumination and the relative costs of lighting.

DISTRIBUTION OF ILLUMINATION.

Indirect lighting in general has been proven to be more uniform than direct lighting, other conditions being equal. When a room is illuminated by this method, obviously the ceiling becomes one of the main sources of light, and just as outdoors on a cloudy day has lighting with smallest shadow, so does the larger light-giving area of a ceiling surface tend towards uniformity of illumination.

Again, the light rays coming from a source to a ceiling will strike the ceiling and be returned at wider angles to farther points on the floor. The much used analogy of the stream of water that is directed downward to destroy a limited area of one's garden, or pointed upward to spray a large part of the ground, explains this condition best. Finally, the ceiling as one light source, and the lamp and shade close to the ceiling as another source, form two sources that average much higher in position above the floor than direct lighting sources, and is another reason for wider distribution and more uniformity.

The ratio of downward to upward light, 1 to 2, mentioned above seems to be an excellent proporition for usual service, although there are places where a larger per cent of transmitted light is advisable, just as there are many places where completely opaque reflectors are advisable. The conditions favoring the first case are units hung high, with a dark ceiling and also high energy costs. The conditions favoring the second case would be under about the reverse circumstances.

THE RELATIVE COSTS OF LIGHTING.

The second consideration is, how much more does it cost to illuminate an office by the semi-indirect system? There are two answers: one is the answer to the question of costs for equal foot-candles; the other to the question of costs for equal ability to see.

It is of interest to note results of a test made upon an installation of six units. The office room to be lighted measured about 38 by 20 feet, with a 10-foot cream colored ceiling, and light yellow walls. Six 150-watt lamps were used, spaced approximately at centers of equal rectangles. The distance of the rims of the shades from the ceiling was 15 inches. Six floor stations were respectively located as follows: directly beneath one of the middle units—of one of the two rows of three units each—directly between the two center units; between the middle and end unit of one row; between four adjacent units; at the wall opposite the middle unit of one row, and at the wall opposite the point between a middle and an end unit; in short, such locations as to arrive at the values of a general average of foot-candles of the whole room. The results are given in Table I.

The foot-candle efficiency is 0.28 watt per lumen. Using the above factor of 18.3 per cent as the decrease of illumination of semi-indirect over direct lighting, an efficiency of about 0.23 watt per lumen for direct lighting in this typical room would be obtained, or a close agreement with the generally accepted results from previous tests of other investigators. This figure of efficiency for semi-indirect lighting is surprisingly good, and may always be applied with a factor of safety.

But this consideration is to be modified for the final answer as to costs. Although under the conditions described, for equal foot-candles the semi-indirect system requires 18.3 per cent higher wattage, the question is not one of equal foot-candles, but of equal visual efficiency. Under the semi-indirect system there is greater ease of vision. On account of the low intrinsic brilliancy of the light source there is a pupillary expansion of the eye, allowing more light to reach the retina. Then there are to be considered the results of Fechner's law, which stated briefly is that a decrease in intensity does not mean a correspondingly large decrease in visual acuity; nor the converse. Were this not so, one who in daylight comfortably uses 30 foot-candles of illumination would be greatly embarrassed in attempting to see by moonlight, with 0.03 foot-candles. Third, the more pleasant appearance of the unit and the personal gratification of the senses places the observer's state of nerves and feelings at a place where the sight recording apparatus—quite nervously sympathetic—operates at its best. It is not an exaggeration to claim that in many cases the increased sensitiveness quite often counterbalances the decrease of foot-candles.

TABLE I. TESTS OF SEMI-INDIRECT LIGHTING UNITS.

Readings of horizontal foot-candles on a 30-inch working plane.

Tungsten 150-watt clear lamps.
Light opal bowls.
Distance: rim to ceiling, 15 inches.
Color of walls and ceiling: cream.

Average of stations............	4.137 foot-candles
Total area illuminated.........	776.0 sq. ft.
Total energy consumption.....	900 watts
Approximate watts per sq. ft..	1.16
Watts per useful lumen......	0.28

In the United States today there are 1,300 electric railway companies, owning and operating 42,000 miles of track, 90,000 cars, carrying between 10 and 11 billion passengers yearly, and employing more than 250,000 persons. The companies already holding membership in the American Electric Railway Association own and operate 30,000 miles of track, 73,000 cars, carrying 7½ billion of passengers in a year, and have 200,000 employes.

Some Results of Poor Line Construction.

BY ROY C. FRYER.

(*Contributed Exclusively to* SOUTHERN ELECTRICIAN.)

If a manager of a small central station be asked what part of his equipment gives him the least trouble, and least loss from occasional shut-downs, he will probably say that his mechanical equipment at the station causes very little loss of revenue by fault of engines, generators or switchboard. He would most likely point with pride to practically perfect mechanical details, mentioning that the best engineering skill obtainable has charge of the problems of generating equipment, and how successfully it has operated. He would probably say further that the only occasional suspensions of service were due, not to faults or trouble with machinery, but to faults in the line.

Ask telephone engineers the same questions and the largest percentage of answers will be as before, that there is little trouble in exchange equipment, but some little line trouble. Line trouble is seemingly of no consequence and almost below the dignity of a good engineer, probably because of the apparent simplicity, yet how many central stations are today losing current, that represents money, through losses in a transmission line not properly designed? How many ground detectors will show the lines perfectly free of grounds? How many efficient generators are showing a steady current through a polished switchboard to a delapidated transmission system?

On such systems as these, many a good customer complains that current is off, when an investigation find a transformer fuse gone, and the revenue for several hours of current consumption lost, where it might have been averted by giving the lines adequate protection.

It is also too seldom recognized that a reduction of the voltage loss permits a little more current to be taken through the meters on the outskirts of town, without taking one pound more coal to produce this revenue.

Let us enter into a study of these line losses. To begin with, let us take up most frequent causes of trouble occasioned on lines, let us analyze each fault and find the cause of it. Let us further assume that the lines are comparatively new, and go back over a period of a few months or a year, and by means of a record of trouble reported find the exact cause of every trouble separately, and classify these causes, and thus find wherein the line work is wanting.

Beginning with January a suspension of service on circuit No. 1 was noticed for a few hours, as an outside pin gave way during a sleet storm, letting a 2,300 volt wire loose, which fell upon another, shorting the circuit and preventing its use until found. It was also learned that on the corner it was first thought wise to place a special construction, with double cross-arms, but later it was found that this line ran a little higher in cost than was expected, so the idea of special construction was given up with the above result. This circuit would have carried a current of 20 kilowatts for the few hours it was out of use, about two or three hours. It cost $3 in labor and material in repairing, and one customer became more dissatisfied at this one added interruption in service, which occurred when his residence was lighted for a dinner party, and he quit using the current and went over to a competitive plant. The following sums up, then, the loss of this one interruption:

Loss of revenue 40 kilowatt hours @ 10c	$4.00
Labor and material to repair line	3.00
Replacement of fuses on circuit	.20
Total	$7.20

It would have cost less than this to have made the corner perfectly secure when building the line, and the reputation for good service would not have suffered.

Studying the records further, it was found that on January 17, service was off at a plant on the end of the line. The main dead end there, and a few spans of secondary complete the line from a transformer at this point to the plant. The secondaries broke during a few days' thaw, the guy gave way where the mains dead ended, throwing the strain on the secondaries, and thus breaking them. Rock was struck in guying this pole, and it was rather neglected.

The loss in this case was as follows:

Repairing	$7.50
Loss of revenue for two hours	3.80
Total	$11.30

In February some minor troubles occurred. Transformer No. 35 failed through overload and a few stores on Market street were without light for a while. This resulted in a loss of about $5.00 in current, and a cost of $25.00 in loss of transformer until repaired. Total, $30.00.

On March 12 the mains were down to Mraket street, a horse killed and an old man injured.

Loss of current	$ 50.00
Compromised suit	500.00
Repairs	10.00
Total	$560.00

On April 1, 2, 3 and 4, a heavy ground came on and it was found that a primary wire leading from the fuse block to the transformer, on Main street pulled down on the frame of the transformer, which was grounded, thus causing a direct ground on No. 1. When the transformer was hung a little wire was saved by taking the lead direct from the transformer to the fuse block, without splicing in another piece, and it just barely reached.

During June and July lightning got in its work and current was off some transformers four and five hours, and the Mechanics Institute contract was lost through irregular serice. Thus in seven months an actual loss of over $600 was experienced from poor line construction. These conditions may be in some respects exaggerated, yet the average small station manager will find much food for thought in the points, and the author will be repaid if no more than one point comes to the attention of a manager experiencing similar losses, in such a way as to be of service.

A Rejuvenation at Atlanta—Electrical Exposition Planned.

The first rejuvenation of the Jovian order under the direction of Statesman M. O. Jackson for Georgia, was held at Atlanta November 19, and was an event to occupy a prominent position in the records for the early part of the 1912-13. Jovian year. This rejuvenation was the first to be attended by reigning Jupiter F. E. Watts, since his election in October. Among other influential Jovians in attendance were past Jupiter H. B. Kirkland, past Appolo W. N. Matthews, reigning Appolo L. S. Montgomery, and other Jovians well-known to the electrical industry. Twenty candidates were taken into the order and represented progressive organizations that are helping to extend the work of the order in the direction of its greatest usefulness.

A banquet was held at the Transportation Club and attended by eighty-four Jovians. Reigning Appolo L. S. Montgomery officiated as toastmaster, calling upon a number for expressions in regard to progressive Jovianism. Reigning Jupiter Watts suggested a number of ways in which the order can accomplish things worth while and dwelt upon his plans to bring these things about. Past Jupiter Kirkland and S. A. Chase reviewed Jovianism, past and future, drawing largely upon their observations while connected with the order and predicting development for the future along substantial lines of support and upbuilding of the order and the industries associated. M. O. Jackson spoke on the work in Atlanta and what had been accomplished, expressing the hope to be able to continue the work. R. C. Turner, city electrician, referred to the influence of the Jovian Order in municipal affairs.

Mr. Montgomery, in the course of his remarks, reviewed his investigations in regard to the possibility of holding an electrical exposition in Atlanta. He stated that he was still at work on the proposition and had not intended to make a statement in regard to it until such a time that the details could be announced. Since, however, the matter had been brought up as a suggestion, he desired to make it known that such an exposition is now practically assured, and further said that the Atlanta exposition will be a Jovian affair, carried out in no small way, for already the large corporations and influential Jovians of this city and elsewhere have pledged their support.

Western Electric Atlanta Sales Conference.

The Western Electric Company's annual Atlanta sales conference was held this year on November 18 to 21. Besides being attended by the local managers, the managers and executives of the electrical supply manufacturers, for whom the Western Electric Company acts as Southern distributor, were also present. Business conditions and general arrangements for handling the Southern trade were discussed.

An enjoyable and important feature of this conference and one looked forward to, is the quiet social functions. On Monday night, November 13, the members of the conference were given a dinner at the Capital City Club by SOUTHERN ELECTRICIAN. On Tuesday the Jovian rejuvenation and banquet were attended, and on Wednesday night a banquet given by the Western Electric branch at the Mechanical and Manufacturers' Club. The conference closed on Thursday.

The following were in attendance at the conference, besides the Atlanta branch managers: F. V. Burton, sales manager Bryant Electric Co.; B. H. Scranton, president American Electric Heater Co.; Robert Edwards, Jr., president of Edwards & Co.; W. N. Matthews, W. N. Matthews & Bros.; J. M. Presbrey, Holoplane Works of General Electric Co.; F. E. Watts, sales manager Sunbeam Incandescent Lamp Co.; A. I. Sundheimer, General Electric Co.; J. H. T. Price, B. F. Sturtevant Co.; H. W. Bliven, Harvey Hubbell Co.; A. B. Wilson, Tungstolier Works of General Electric Co.; Samuel A. Chase, Westinghouse Electric & Manufacturing Co.; Adrian Tobias, Westinghouse Electric & Manufacturing Co.; H. R. King, power apparatus sales manager, Western Electric Co.; E. A. Hawkins, telephone sales engineer, Western Electric Co.; M. A. Oberlander, assistant supply sales manager, Western Electric Co.; H. B. Kirkland, president American Conduit Mfg. Co.

Convention of Alabama Light and Traction Association.

While this issue of SOUTHERN ELECTRICIAN is on the press, one of the most successful conventions of the Alabama Light and Electric Association is in session at Birmingham, Ala. At this meeting practically every member company is represented and in most cases by members of the executive and technical branches of these central station organizations. There are in the state of Alabama some 70 central stations and the above association now has as a membership nearly one-third of these stations. There was every assurance that this number will be considerably increased during the next year.

A number of special papers were read at the different sessions and an enthusiastic discussion followed the presentation of each in which representatives of nearly all statios present offered comments and suggestions. The address of President C. E. White, also president of the Montgomery Light and Water Power Company, was the feature of the morning session of the first day. He outlined the work of the association and urged that every member enter into this work and not only make the association what it should and can be, but secure for each and every member the benefits possible from the co-operation of all Alabama central stations. The following program was carried out:

THURSDAY, NOVEMBER 14, MORNING SESSION. A Talk on Rate Research by B. W. Offutt of the Alabama Power Co.; a paper on Residence and Store Lighting, read by A. M. Klingman in the absence of the author, J. C. Henninger, of National Quality Lamp Division of G. E. Co.

THURSDAY, AFTERNOON SESSION. Paper on Street Lighting by A. M. Klingman of National Electric Lamp Association Engineering Department; a paper on Street Railway Matters and the Double-Deck Car, by L. D. Mathes, of the Montgomery Traction Co., Montgomery, Ala.; and a paper on Retort House Practice, by C. W. Wallace, of the Gas Department of Montgomery Light and Water Power Co.

FRIDAY, NOVEMBER 15, MORNING SESSION. Association Work in the South as Seen by the Editor, by D. H. Braymer, Editor SOUTHERN ELECTRICIAN; a paper on Small Tenement Consumers, by A. F. Kersting, Supt., Mobile Gas Co.; a paper on Accounting Matters by V. B. Day, secretary and treasurer, Montgomery Light and Water Power Co.

AFTERNOON SESSION. A paper on Increasing the Day Load by F. V. Underwood, of the Birmingham Railway Light and Power Co.

The officers elected for the coming year are as follows: President C. C. Henderson, of the Henderson Light and Power Co., Greenville, Ala.; vice-president, R. L. Ellis, of the Selma Light Co., Selma, Ala.; secretary and treasurer, H. O. Hanson, of Mobile Electric Co. The association offered an appropriate resolution of appreciation for the earnest work of the past-secretary, Mr. G. S. Emory, of the Mobile Electric Company, who is soon to leave the state to enter into a private business in the west.

A complete report of this convention, giving abstracts of the papers presented and the discussion on same, will appear in the next issue of SOUTHERN ELECTRICIAN.

Georgia Railway and Power Company Shows Customers Tallulah Falls Development

The Georiga Railway & Power Company, of Atlanta, is conducting trips on Tuesdays and Fridays to its Tallulah Falls hydro-electric development. These trips are conducted by Mr. Milt Saul, in charge of publicity department, and Wm. Rawson Collier, in charge of the contract department. Invitations are issued to all customers, city officials, mill owners and managers and others interested in the development work, all the expenses, including transportation

and meals being arranged and paid for by the Georgia Railway & Power Company.

This scheme has worked out very effectively both from the standpoint of the company and those who are contemplating the purchase of power from the system. It further familiarizes many with the extensive nature of the work and the details in the construction of a plant to develop 90,000 horsepower. All who make the trip are impressed with the proposition and have naturally an increased confidence in the corporation which either is or will be closely associated with their businesses.

Parties are being taken from all towns along the line of the transmission system and members of the contract and publicity departments are present with printed data and photos of the system to explain any questions that may come up. All parts of the work are visited, including a trip down the fore-bay, some 100 feet to the exit of the tunnel, and inspections of power house and switch house under construction, the inlet end of tunnel and dam and the temporary compressor and electric plants to provide air and light for construction work. The work will be completed about the first of the year.

Mississippi Electrical Association Question Box.

Under this heading will appear each month questions and answers to questions from members of the Mississippi Electrical Association. All readers are invited to discuss any question or topic presented. Address all correspondence including questions and answers to Clarence E. Reid, Question Box Editor, Agricultural College, Miss.

QUESTION NO. 1.

What is standard practice regarding the use of an air chamber on discharge line boiler feed pumps?

QUESTION NO. 2.

A town has a grounded non-metallic telephone system installed, and on the same poles it is desired to run A. C. 2,300 volt 60 cycle wires. Clearance between A. C. wires and 'phone wires to be 2.5 or 3 feet; what interference will be experienced in the phone system due to inductance. If a 133 cycle system were installed, would the 'phone service be worse than it would be if 60 cycle current were in the wires?

QUESTION NO. 4.

In addition to sending out 3-phase 2,300 volt, 60 cycle lines, a station wishes to send to near-by consumers, 3-phase, 3-wire, 110 volt circuits, fed from two transformers of not more than 15 K. W. each. Is it permissible, or good practice to set these oil-filled transformers, on the floor back of the switchboard, or mount them on a brick wall at the rear of the board, or place them in the boiler room at the rear of the board, beyond this wall, or is it necessary to run the 2,300 volt lines out of the station, to transformers mounted on poles or other outside structure, and then run the 110 volt lines back to the board? These 110 volt lines are controlled by 3-phase carbon break circuit breakers.

In any of the above situations of the transformers, is it good practice to connect the transformers direct to the 2,300 volt fuses, without oil or other primary switches? The oil switch on the generator is non-automatic. If an automatic switch is not used on primary side of these transformers, are primary fuses necessary or desirable?

QUESTION NO. 5.

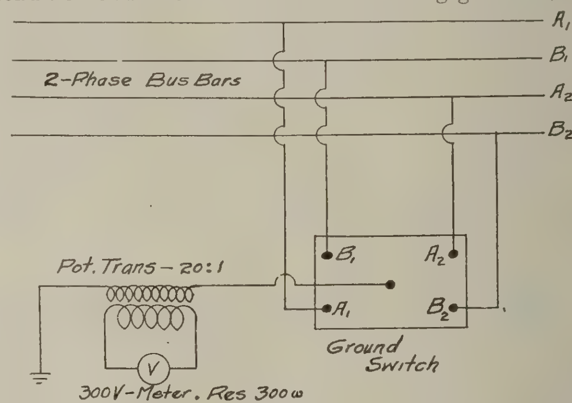
A station wishes to run 2,300 volt three-phase lines a distance of 120-feet along a vertical wall, about 20 feet from the floor. Is the use of porcelain insulators good practice? How far apart should the lines be supported? What should be the spacing of the supports of one line? If porcelain insulators are not recommended, what are most used?

QUESTION NO. 5.

The sketch shown here refers to a two-phase plant, using transformer type ground detector. The following readings were noted, with all line switches open, for first set, and second set taken with all line switches closed:

	All lines open.	Closed.
When A_1 is selected, voltmeter reads..	61	66.5
When A_2 is selected, voltmeter reads..	61	65.0
When B_1 is selected, voltmeter reads..	61	68.0
When B_2 is selected, voltmeter reads..	61	68.5

When line switches were open, giving the first column of readings the house or station primary circuit was connected where it taps the fuses. Do these readings indicate a condition of station and outside lines being grounded? If

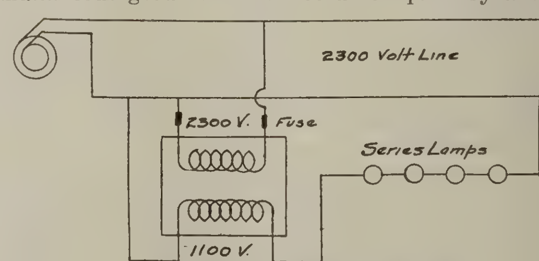


GROUND DETECTOR DIAGRAM.

so, how serious are the grounds? If not, what is the explanation of the readings of the voltmeters? Is there naturally and normally a difference of potential between the ground and any conductor of a high voltage system?

QUESTION NO. 6.

A plant, to save some line copper, desires to use the above connection. What are the objections, supposing simultaneous grounds should occur on primary and on in-



ECONOMICAL WIRING SCHEME.

candescent circuits, of greater or less serious nature? What objections, supposing both lines free from grounds?

QUESTION NO. 7.

How do member companies store and care for their reserve supply of transformer oil? When moisture is suspected, how do you test it? When moisture is found in the oil, how do you remove it?

QUESTION NO. 8.

Do members experience trouble with cotton gin loads on account of large motors used and consequent demand on the station at no regular period? What rates have been found suited for this load?

New Business Methods and Results.

Representing Interests of Central Station, Electrical Jobbers, Dealers and Contractors.

Christmas Merchandising—The New Business Manager's Eternal Problem.

With the approach of Christmas, young and old begin to ask themselves some very important questions. In the mind of the small boy and girl this question takes form: "I wonder what Santa Claus will bring me?" the prospective donor wonders, "What shall I give?" while the thought uppermost in the mind of the merchant is, "What shall I lay in for the Christmas trade?" For the purpose of this discussion, we will put it thus: "What should Christmas mean to the Central station and all other electrical merchants?"

The Central Station is already assured of a considerable increase of business due to the activities attending the holidays, and the increased use of light in stores, homes and places of entertainment; but besides this, there is a great opportunity for the introduction of current-consuming devices by taking advantage of the custom of making gifts.

While, of course, the idea of profit is the primary aim of the electrical merchant in marketing his goods, yet the motive need not and should not be altogether selfish, for business opportunities can be used to further the Christmas spirit referred to as the custom of giving gifts. The community in general and customers in particular are benefited by calling specific attention to the newest and best electrical devices for household and personal use. Thus in making the trade a source of profit to the Central Station it is promoting the comfort and luxury of people in general.

GIVE SOMETHING ELECTRICAL.

Many dealers and Central Stations have adopted this as a Christmas slogan, and while at first thought it may seem altogether a selfish appeal, let us see if there are any reasons why such devices have any particular advantages as gifts. In the first place, they are comparatively new, and among them we find many charming and useful novelties. Those who have Christmas gifts to select are always looking for something new, and therefore novelties have a decided advantage. Electrical appliances, as a class, have been in use about long enough to be fairly well known and to have created an active demand for them.

Again, electrical devices in general are eminently useful. Some one has said that every other Christmas gift is foolish, and probably spoke from the depths of his own experience. In many cases this is because they are bought in a rush, without serious thought. Any effort, therefore, which will influence the purchase of useful things is a real service to humanity.

Further, these appliances bring convenience, comfort and luxury. Their frequent use is associated with pleasurable emotions, and this gives rise to feelings of regard and appreciation. The donor who wants to give something of real service, and which will give real pleasure every time it is used, will, therefore, do well to give something electrical. Finally, they are durable, and will therefore be enjoyed for a long time.

THE OPPORTUNITY.

While it is true that the sale of current-consuming devices may be and should be pushed at all times, yet there is an especially good opportunity to introduce them at the Christmas season, and for the following reasons: In the first place, first cost becomes of less importance, for people are inclined to be more liberal at this time. While most of these devices are not prohibitive in cost and while it is usually possible to persuade a person that they are a good investment, yet many persons will buy them as gifts for some one else, but do not buy them for themselves. It is also a fact that many persons will use and appreciate articles given to them, that they would not, or could not, have purchased.

Furthermore, in trying to make a sale of electrical appliances, nearly always the question is asked, "How much does it cost to run it?" While there are but few cases where this is a serious objection, it may be given as an additional excuse for not purchasing for use by the purchaser. In the case of a gift for some one else this point is seldom seriously raised, since the donor is concerned only with the purchase price. The cost of current is not really much of an objection at all, as shown by the fact that we seldom hear of such a gift being laid aside because it consumes too much electricity. In short, the fact that the initial expense and the operating expense are to be borne by two separate parties has made it easier to sell the article.

THE APPEAL.

First, it is evident that whatever selling efforts are to be made at this time, must be such as will stimulate immediate action. It is not sufficient to simply arouse a general interest. This should have been done long before, and all the time by advertising, solicitation and general publicity methods. The public should have been well informed as to all the possible uses for electricity, and the only purpose of holiday advertising and display should be to bring about the purchase of these goods as Christmas gifts. If the general advertising has been neglected or poorly done, it will serve as a handicap to the Christmas merchandising.

THE METHODS.

There are at least four methods that can be used to secure new business, advertising, circularizing, display and demonstration. Solicitation is of no value at this time. It is not "red hot" enough. It can reach but a trifling proportion of the people at the psychological moment. Liberal newspaper advertising should be used for three or four weeks, preferably confining each advertisement to a simple line of thought, and changing every day or two. It is a good idea to use some slogan running all through the advertising, such as "Give something electrical," or "Have an electrical Christmas this year," in order to so impress the thought upon the minds of the reading public that they will have this idea in their minds when they are ready to buy.

SUGGESTIONS GRATEFULLY RECEIVED.

The selection of gifts is such a source of perplexity to many persons that they will gladly welcome any suggestions

along this line. This fives the central station and the electrical dealer a fine chance to do some very valuable advertising, by sending to a selected list of customers a booklet which might be entitled, "Suggestions for Christmas Gifts," in which a brief statement might be made of the advantages of electrical devices as gifts, followed by a list of such articles with the prices. These may be arranged according to the needs masculine, feminine, juvenile, or otherwise. A few tasty cuts will add to its attractiveness and such a booklet will be sure to be preserved and consulted.

IMPORTANCE OF DISPLAY.

The window and the showroom are of special importance at this time of the year. Ordinarily the display of a central station may be said to be definitely auxiliary to its other efforts for the extension of business, but at the holiday period the character of the display determines as nothing else, the volume of business possible. Christmas gifts, as a rule, are selected as the result of shopping expeditions, from which people return with those things that have taken their fancy. It therefore follows that to sell these goods, they must not only be displayed, but in order to compete with other merchants handling different lines, the same care must be used as they do to make windows and showrooms attractive. A number of interesting contributions appear in this number, giving some plans that have been used in this connection.

We would strongly urge that all of the display be arranged with the one end in view of calling attention to the possibilities of electrical goods as holiday gifts. Use can be made, of course, of artificial snow, tinsel, small Christmas trees, holly wreaths, dolls, and such things to make windows attractive, but they should be used with judgment, care being taken not to use valuable space for things which will not contribute to the success of the sale. It is quite possible to fix up a window at considerable expense of time and money with large dolls, trees, toy railroads, log cabins, and other scenery, produce a fine effect, attract a great deal of attention, yet not sell a dollar's worth of any goods. People will stop, look, laugh, and admire and pass on to buy their Christmas presents somewhere else.

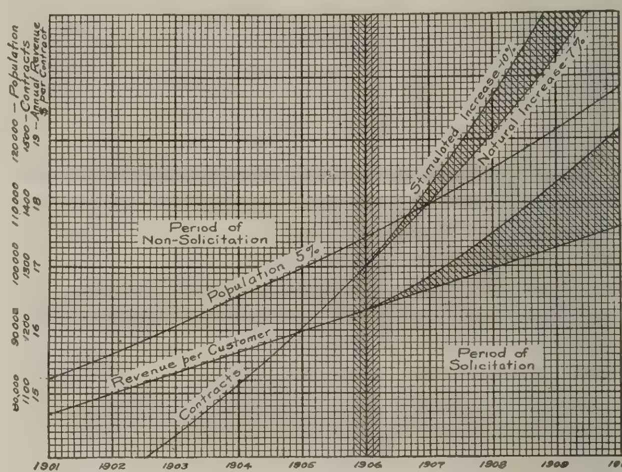
DEMONSTRATIONS AND SOUVENIRS.

Much of what has been said about window display is true of demonstrations. If they are to be used at all, this is the time to have them. While people are Chrismas shopping and open to impressions, they will take time to watch a demonstration and inquire into the merits of the article. This is especially the case if a demonstration of some novelty is arranged for, since as we have pointed out, new things have the advantage as gifts. Souvenirs may be made of use. In one large city an advertisement was inserted to the effect that all ladies who would call at the electric light office during a certain period would receive a valuable souvenir. There were 3,000 applicants, which shows plainly that if the appeal is properly made, it will produce the desired effect. It seems that this would be a specially good time of year to make use of this method, and would probably be a means of bringing many possible customers within the influence of the display.

Natural and Cultivated Growth.

In the November issue a correspondent raised the question as to whether or not it is just to regard any part of the growth in the use of electric service as "natural," as distinguished from "cultivated," and was inclined to believe that all increase whatever in the business is the result of cultivation. There is of course a sense in which this is true, but it is yet possible in most cases to differentiate between the increase of business which comes without definite on the part of the central station, and that which is stimulated by new business methods, just as we can distinguish between a plant grown out-of-doors and one grown in a green house. It is often difficult, if not impossible, to give each factor its exact quantitative value, yet at least two elements can be found at work.

We illustrate herewith a set of curves which illustrate this. The period from 1901 to 1906 was one in which there were practically no solicitors in the field nor any organized effort made to secure business. At that time a commercial department was formed and solicitors put in the field. The population has increased regularly at the rate of 5 per cent



CURVES OF BUSINESS GROWTH.

per annum. The growth is shown in two ways, first, by the number of contracts, second, by the revenue per customer per year. We could similarly plot contracts per capita, or revenue per capita, or anything else as a basis of growth. From 1902 to 1906 the growth in business as represented by the contracts in force is increasing at the rate of 7 per cent, and this is continued by the line below the shaded area. With the establishment of the new business department, this increase became 10 per cent and the line at the top of the shaded area from that year shows the results. Evidently the shaded area may be said to fairly represent the work done by the commercial department, as shown by the contracts in force.

It is to be remembered that the commercial department does more than secure contracts. The solicitors are constantly making better customers out of the present customers. Consequently we represent their work on the basis of average consumption, as shown by the other curve.

A. G. RAKESTRAW.

SUGGESTIONS FROM READERS.

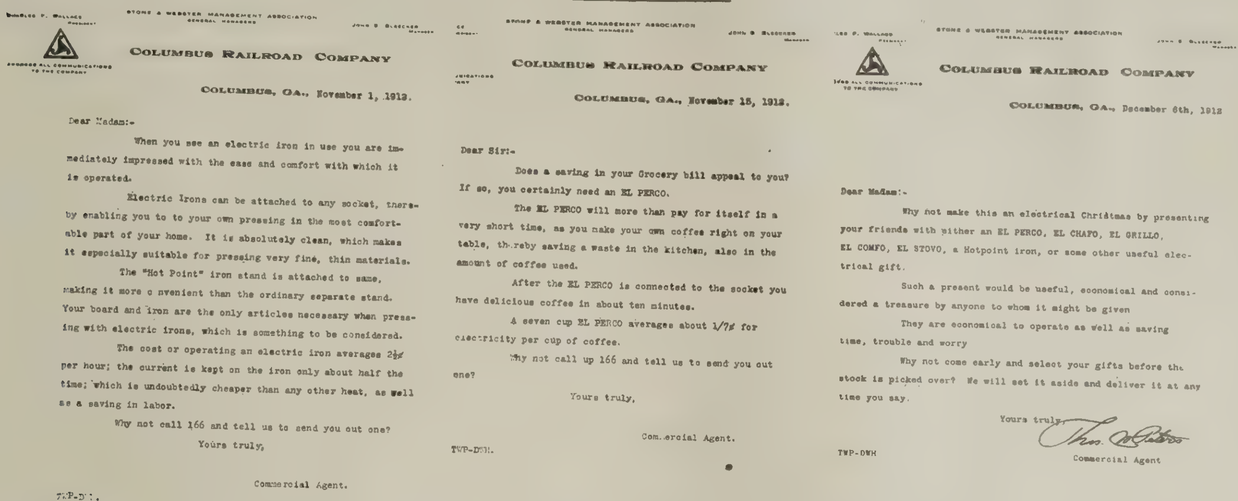
Mr. Thomas W. Peters, Commercial Agent Columbus Railroad Company, Columbus, Ga., on Christmas New Business Schemes and on Special Installments in Columbus Laundries.

The writer submits here the first of a series of advertisements which he plans to run on heating devices. This advertisement appeared on Sunday, November 17. We expect to carry out this same idea, making the price of the combination a secondary consideration in these advertise-

ments. As each advertisement appears in the paper, we expect to display this combination in our window with a card on which will be printed, "Make Electricity Your Willing Servant," the price being put in large type just below this heading. We have found that to make this display show up to the best advantage, we use a square of black velvet on which is placed the different devices.

well as motors. The management is very well satisfied with same, claiming they make a considerable saving over their previous method of driving, which was a steam engine belted direct to line shaft. Equipment in this laundry follows:

Eight 7½-pound irons; one 2 K. W. electrically heated body iron; one 2 bosom press using ½ K. W. for heating in each bosom compartment.



COLUMBUS RAILROAD COMPANY

COLUMBUS, GA., November 1, 1912.

Dear Madam:-

When you see an electric iron in use you are immediately impressed with the ease and comfort with which it is operated.

Electric Irons can be attached to any socket, thereby enabling you to to your own pressing in the most comfortable part of your home. It is absolutely clean, which makes it especially suitable for pressing very fine, thin materials.

The "Hot Point" iron stand is attached to same, making it more c nvenient than the ordinary separate stand. Your board and iron are the only articles necessary when pressing with electric irons, which is something to be considered.

The cost or operating an electric iron averages 2½¢ per hour; the current is kept on the iron only about half the time; which is undoubtedly cheaper than any other heat, as well as a saving in labor.

Why not call 166 and tell us to send you out one?

Yours truly,

Commercial Agent.

TWP-D.

COLUMBUS RAILROAD COMPANY

COLUMBUS, GA., November 15, 1912.

Dear Sir:-

Does a saving in your Grocery bill appeal to you? If so, you certainly need an EL PERCO.

The EL PERCO will more than pay for itself in a very short time, as you make your own coffee right on your table, thereby saving a waste in the kitchen, also in the amount of coffee used.

After the EL PERCO is connected to the socket you have delicious coffee in about ten minutes.

A seven cup EL PERCO averages about 1/7¢ for electricity per cup of coffee.

Why not call up 166 and tell us to send you out one?

Yours truly,

Commercial Agent.

TWP-DWH.

COLUMBUS RAILROAD COMPANY

COLUMBUS, GA., December 6th, 1912

Dear Madam:-

Why not make this an electrical Christmas by presenting your friends with either an EL PERCO, EL CHAFO, EL GRILLO, EL COMFO, EL STOVO, a Hotpoint iron, or some other useful electrical gift.

Such a present would be useful, economical and considered a treasure by anyone to whom it might be given

They are economical to operate as well as saving time, trouble and worry

Why not come early and select your gifts before the stock is picked over? We will set it aside and deliver it at any time you say.

Yours truly,

Commercial Agent

TWP-DWH

FIG. 1. THREE CIRCULAR LETTERS TO BE USED BEFORE CHRISTMAS.

I also submit a series of letters which we are going to use during the coming months. It is too early now to state just what the results of this campaign will be, but we hope that it will be the means of getting people to buy electric heating apparatus for not only Christmas presents to be used by their friends, but make them think of using these labor-saving devices in their own homes.

It may be of interest to note here a recent special installation made in a laundry. We have one laundry which is completely equipped with electrical heating apparatus, as

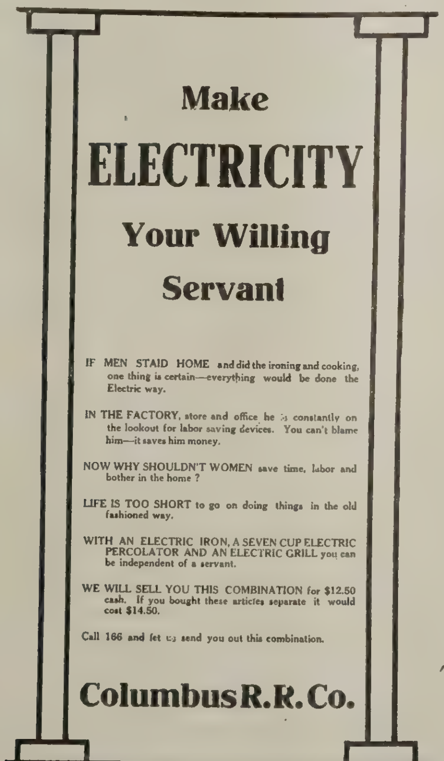
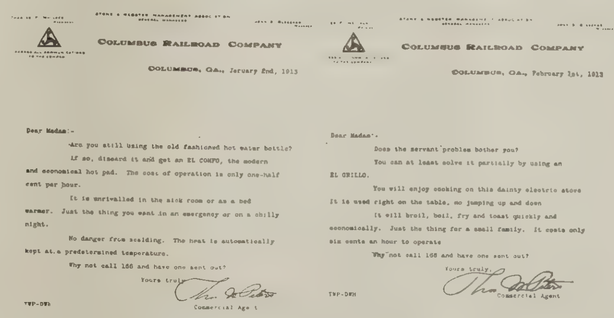


FIG. 3. A NEWSPAPER ADVERTISEMENT ON HEATING DEVICES.

The motors are arranged as follows:

One ½ H. P.—1,800 R. P. M.—form K, G. E., 2-phase induction motor, drives a shaft on which is placed an 8-inch collar dampener, one steam dampener, also one starching machine. This motor is located under the table on which is placed all above apparatus except starching machine.

One, 2 H. P.—1,200 R. P. M.—Form K, G. E., 2-phase induction motor is used to drive a 30-inch collar and cuff ironer. This ironer is heated by steam from their present



COLUMBUS RAILROAD COMPANY

COLUMBUS, GA., January 2nd, 1913

Dear Madam:-

Are you still using the old fashioned hot water bottle?

If so, discard it and get an EL COMFO, the modern and economical hot pad. The cost of operation is only one-half cent per hour.

It is unrivalled in the sick room or as a bed warmer. Just the thing you want in an emergency or on a chilly night.

No danger from scalding. The heat is automatically kept at a predetermined temperature.

Why not call 166 and have one sent out?

Yours truly,

Commercial Agent

TWP-DWH

COLUMBUS RAILROAD COMPANY

COLUMBUS, GA., February 1st, 1913

Dear Madam:-

Does the servant problem bother you?

You can at least solve it partially by using an EL GRILLO.

You will enjoy cooking on this dainty electric stove It is used right on the table, no jumping up and down

It will broil, boil, fry and toast quickly and economically. Just the thing for a small family. It costs only six cents an hour to operate

Why not call 166 and have one sent out?

Yours truly,

Commercial Agent

TWP-DWH

FIG. 2. CIRCULAR LETTERS TO BE USED AFTER CHRISTMAS.

boiler. This motor is located on the floor just about 3 feet in rear of this machine belted direct.

One, 1 H. P.—1,200 R. P. M.—G. E., form K, 2-phase induction motor is belted to a line shaft from which is run a 36-inch bosom iron and a 2 bosom press. Both of these pieces of machinery are electrically heated. This motor is placed on the floor in rear of the two machines and is belted to the line shaft, which is in the basement directly under the two machines.

One, 2 H. P.—1,800 R. P. M.—G. E., form K, 2-phase induction motor, back geared 7 to 1 ratio, drives a mammoth mangle which is heated by steam. This motor is placed on the floor just at the side of this machine.

One, 7½ H. P.—1,800 R. P. M.—2-phase G. E. induction motor equipped with overload and no voltage release drives a line shaft on which is belted four washers and two

extractors. This motor is located on ceiling and these washers have a capacity of 100 shirts.

One, 1 H. P.—1,200 R. P. M.—G. E. 2-phase induction motor drives a line shaft to which is belted a machine for two dry rooms. This machine consists of two large paddle fans and one automatic collar conveyor. This motor is also located on the ceiling.

Besides the above, there are approximately 25-16 C. P. quivalents in lamps. The consumption shown on the meters for the apparatus is as follows:

HEATING APPARATUS.

June ....690 K. W. H.	Sept. ....1141 K. W. H.
July ....861 K. W. H.	Oct. ..... 936 K. W. H.
Aug. ....955 K. W. H.	

ON MOTORS.

June ....540 K. W. H.	Sept. ....1327 K. W. H.
July ...1165 K. W. H.	Oct. .....1247 K. W. H.
Aug. ...1143 K. W. H.	

ON LIGHTS.

June .....11 K. W. H.	Sept. .....30 K. W. H.
July ......17 K. W. H.	Oct. ......43 K. W. H.
Aug. ......13 K. W. H.	

We also have another laundry in Columbus which is using electricity for motors and irons, also lights, but it is not as completely equipped as the above laundry. These people expect to move in a very short time and are going to put in individual drives on all machines.

Mr. R. B. Mateer, Manager Agricultural Sales, Great Power Company, San Francisco, on Xmas Displays.

What central station can see the holiday season approach and feel that they have nothing to interest the public? Is it desired to see this season of joy pass into history without some returns in the shape of increased revenues from the sale of current or increased profits from the sale of electric appliances? Central stations as a rule have endeavored to be allied to every opportunity offered them for the marketing of their products at least so far as increased consumption is concerned but how many managements are awake to the necessity of maintaining attractively decorated windows and of joining in with the general spirit of the occasion? Why not now order a stock of electric irons, toasters, disc heaters, electric stoves and radiators? Have them delivered and unpacked by the first of December, and then decorate your windows attractively. For instance, the first week in December have a beautiful breakfast table complete with china, silverware and all the necessary electric appliances such as a toaster, egg cooker and percolator. Under the chair have a foot warmer for those who have been roused early from their slumbers and who might enjoy some warmth on a cool morning. In the center of the table place a rich and plain electric table lamp. Do not have too many appliances flanking this display, but maintain in the shop a demonstration of those displayed in the window. Toast some bread, boil some eggs and the window will invite attention. Such a demonstration brings customers into the building, and the salesman can do the rest.

The second week before Christmas should be devoted to a display exhibiting appliances used in preparing a luncheon, and demonstration should be carried on in the main portion of the shop.

The next week a dinner bringing into use other appliances for cooking and for lighting purposes could be used. Place an electric range on demonstration this week, and to those who come within reach of a salesman give, if you please, a sample of the food cooked in the electric oven, and finally within a few days of Christmas deck the windows with spruce trees covered with miniature bulbs of every shape and color. Surrounding the trees should be neatly prepared packages, each containing an electric appliance, and with the greetings of the season attached. Many an iron and other current consuming appliance is sold just by the use of attractive displays adapted to the season combined with demonstrations and the ability of a salesman. There are many seasons. A Central Station can be successful and must join in with the occasion.

S. H. Alexander, of the Public Service Corporation of Newark, N. J., Outlines the Xmas Display Used in 1911 and for This Year.

The Public Service Corporation maintains at all times elaborate displays in large show rooms and is at present endeavoring to bring every office, even the very small ones, up to a certain standard, which will represent character and dignity. Weekly changes are made in our show windows, and the merchandise on display is selected in accordance with the season. For instance, we have a schedule which is made up six months in advance and forwarded to every agent in our thirty-odd offices. This gives him an opportunity to be prepared ahead of time with the necessary property to make displays. I enclose herewith a sample sheet as the agent receives it.

To All Agents.
Dear Sir:
We give below for your information a revision of our schedule for window displays:

MONTH OF NOVEMBER, 1912.

	Electric	Gas
Nov. 4	Laundry Exhibit	Lighting.
" 11	Decorative Novelties	"
" 18	Percolators	Cabinet Gas Cooking.
" 25	Portable Lamps	" " "

MONTH OF DECEMBER, 1912.

Suggestion	Christmas Gifts Portables	Christmas Gifts Portables

Decorative Novelties, Chafing Dishes, Toasters, Percolatrs, Fine Domes and Fixtures, Royal Reflex Christmas-Tree Lights, Gas Ranges showing Christmas mal being cooked; use Christmas boxes and paper to tie up packages; use green, red or white to decorate windows and interior; anything suggestive of the season will be appropriate at at this time.

Yours very truly,
P. S. YOUNG, Comptroller.

While we exhibit in our windows a certain appliance, such as electric toasters, we usually have a demonstration going on in our show room, where a table is spread and a young lady in attendance demonstrates the working principle of the appliance and serves toast and tea to interested visitors.

To give an idea of what we have previously done during the Christmas period, I might say that in the window last year was shown a Christmas tree trimmed with tinsel and strings of electric lights burning. On the floor of window were shown packages and boxes neatly tied up with holly paper and ribbons, with Christmas tags attached, Merry Christmas, for Mother, Father, Brother, Sister, Grandma, etc. We also showed specimens of the appliances exposed on the floor and on a small table placed in the window. This made a very timely and suggestive display. In our show room was shown electric appliances of every description, together with fine portables, etc., displayed on tables grouped and arranged conveniently and artistically. All appliances sold at this time are put up in neat holly boxes and wrapped

in paper to match and tied with ribbon. The interior and show room was draped with garlands of holly and strings of electric lights.

N. H. Boynton, Manager Department of Publicity, National Quality Lamp Division of G. E. Co., Suggests Holiday Schemes to Secure New Business.

The holiday season furnishes big opportunities to the central station, electrical contractor and dealer, for increased sales in current-consuming devices and for the stimulation of the general business. We therefore believe that the articles featured in the December issue of Southern Electrician will be very timely.

The increased amount of Christmas shopping and the special prominence of the merchant's display windows, at this season, for compelling the attention of the gift-buying public, furnish two very cogent reasons why he should aim to make his displays more than ordinarily attractive. At no other time of the year do his windows have greater advertising value, and while they are viewed by hundreds, and perhaps thousands, of people through the day time, they perform their office more effectively after sundown, when the crowds throng the streets for recreation and sight-seeing. Moreover, a well-lighted display after dark appears to better advantage than it does under natural daylight illumination. In the daytime every window along the street is illuminated to approximately the same intensity. At night, however, for the merchant who wishes to make his windows stand out in contrast to all the others, artificial illumination is his best card.

If these facts are brought to the merchant's attention in a convincing way through solicitors or letter, it should be an easy matter to induce him to bring the illumination of the windows up to a high standard of effectiveness. A special campaign to this end should be fruitful of results.

Christmas decorative schemes involving the use of incandescent lamps in homes, stores, public halls, dining rooms, churches and places of amusement, together with Christmas tree lighting, furnish an opportunity for the sale of decorative and miniature incandescent lamps. The superiority of these over the old-fashioned wax candle might be emphasized by dealers and central stations through special advertising literature and by featuring them in their window displays. Decorative lighting by means of strings of miniature lamps is becoming more popular every year, owing to the convenience and safety it offers. Incidentally, it might be well to mention the fact that a 25-watt Mazda emits comparatively little heat and when even these larger lamps are worked into decorations they reduce the risk of fire.

It is a common experience of every electrical dealer and central station which has given special attention at this time of the year to the display of electrical devices that Christmas sales constitute a very respectable proportion of the total sales of the year. Electrical merchandizing methods should conform to those employed in the sale of any other commodity. Almost every other kind of goods is featured as especially suited for Christmas gifts; why not, then, electrical goods? Many articles sold as staples throughout the year are put up in attractive packages with special wrappings during the Christmas season. During the past year the cartons containing National Quality Mazda lamps have been changed from single lamp cartons to those containing five lamps each. Why should not the Christmas package idea apply in the sale of these? A box of five lamps neatly wrapped with an attractive figured paper should prove a useful and appreciated gift. Packages thus wrapped might be displayed to advantage in dealers' windows or on the tables within their stores.

Portable lamps comprise one of the most popular of Christmas gifts. These present further opportunities for the sale of lamps, and can be made an attractive feature in the window display or on the counters in the interior. We might suggest special house wiring campaigns during the month of December. These would, of course, give rise to the use of a greater number of incandescent lamps.

In conclusion, it is the opinion of the writer that the Christmas season offers so many opportunities to the dealer in electrical goods that every effort should be made on his part to turn the Christmas buying spirit into profits for himself.

Mr. G. R. Trumbull, Commercial Manager, Meridian Light & Railway Co., Outlines Arrangements for Securing Christmas Trade at Meridian, Miss.

While the writer has not planned any particularly special scheme for securing holiday trade, he is arranging with two of the largest department stores in Meridian to place a table on their main floor with a complete line of electrical devices displayed. A lady demonstrator will have charge of each table and will show the appliances in actual operation. The department store will be allowed a liberal commission on each sale made.

In conjunction with this display advantage is to be taken of an offer made by a manufacturer to supply a hand case equipment for use by a couple of special men working in our residence section. These men will commence work on December 1 and specialize on electrical devices only of the Hot Point Electric Heating Company's make. The writer is of the opinion that this activity should bring considerable results.

A Motto and a Policy.

"Count that day lost,
Whose low descending sun
Sees goods sold at cost
And business done for fun."

The above appears on one side of a retail price sheet applying to Emerson fans, issued by the Burgess-Granden Company, Omaha, Nebraska. On the reverse side of the card appears the following, accompanying a schedule of retail prices: "We do not sell goods at cost, neither do we do business for fun. The Burgess-Granden Company would not be a credit to Omaha if we did. But we do get a lot of fun out of doing business, because we have always made it a rule to handle only the very best of everything in our line."

Different oils have been tried in transformers, but at the present the mineral oil is used exclusively. A good grade of oil should show very little evaporation at 100 degrees C. and should not give off gases sufficient to produce an explosive mixture with the surrounding air with the temperature below 180 degrees C. It should, of course, be neutral and be free from acid or alkali reaction.

Questions and Answers from Readers.

We invite our readers to make liberal use of this department for the discussion of questions as well as for obtaining information, opinions and experiences from other readers. Answers to questions or letters need not conform to any particular style. All material is properly edited before publishing it. Discussions on the answers to any question or on letters are solicited, however, the editors do not hold themselves responsible for correctness of statements of opinion or fact in discussions. All published matter is paid for. This department is open to all.

AMOUNT OF COPPER FOR VARIOUS SYSTEMS.

Editor Southern Electrician:

(335) In comparing the amounts of copper required by different systems, the single-phase two-wire system is usually taken as 100 per cent, when the percentages for the other systems are as follows: Two-phase four-wire 100 per cent; two-phase three-wire 72.9 per cent; three-phase three-wire 75 per cent; and three-phase four-wire 33.3 per cent. I would like to have some reader explain how these percentages are calculated. W. S. B.

ALUMINUM VS. COPPER WIRE.

Editor Southern Electrician:

(336) The writer desires to know if the same formula can be used for calculating the size of aluminum wire for transmission system as is used for copper wire. Also when the tensile strength of hard drawn aluminum wire per square inch is given as 33,000 pounds for a ¼-inch wire as against a tensile strength of hard drawn copper wire of 50,000 pounds per square inch for No. 3-0 wire, what are the particular advantages that decide the use of aluminum? H. A. D.

INDUCTANCE AND CAPACITY IN D. C. CIRCUITS.

Editor Southern Electrician:

(337) The writer desires to know if inductance and capacity are present in all D. C. circuits and if so are the effects the same as in A. C. circuits when the value of current frequently changes? In the design of D. C. apparatus is capacity and inductance considered? W. D. R.

SERIES MULTIPLE WIRING.

Editor Southern Electrician:

(338) What are the actual conditions that exist or may exist in a series multiple system that cause the underwriters to refuse to approve this method of wiring? Give a diagram and explain. C. E. MacL.

FUSING SECONDARY CIRCUITS OF DISTRIBUTING TRANSFORMERS.

Editor Southern Electrician:

(339) We have several banks of transformers on our residential system but not all in any bank are of the same size. After reading the answer to question 317 on banking transformers by Mr. Seidell, I would like to know if there is any condition which would interfere with using fuses to divide the secondaries into sections so as to locate any trouble due to short-circuits? If so, please explain. H. W. W.

INDUCTION MOTOR WIRING

Editor Southern Electrician:

(340) The writer has recently taken a new position where he finds a 100 horsepower Westinghouse motor, of type CCL, 3-phase, 220 volts, wired according to the sketch shown here. The motor runs all right but I desire to know why the entrance wires are crossed. Also why is one of the current transformers placed on the middle wire? Since the motor and meter are 220 volts, is not the voltage between outside wires and between each outside and middle

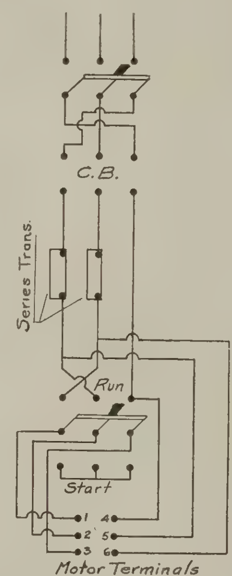


DIAGRAM OF WIRING TO INDUCTION MOTOR.

wire 220 volts? With the wiring as it is, how can the rotation of the motor be changed? Why is the starting side of the starting switch short-circuited? Kindly furnish a diagram that straightens out this wiring and show connections to a 220 volt polyphase watt meter.

ELECTRICIAN.

CHANGING COMPOUND TO DIFFERENTIAL MOTOR.

Editor Southern Electrician:

(341) Can a cumulative-compound motor be changed to a differential-compound motor by reversing the series field? How will the motor operate when so changed? A. C. H.

Liability in Trimming Trees for Line Wires.

Editor Southern Electrician:

The writer has noticed that Mr. Davis in his answer to question 312 did not touch upon the liability connected with tree-trimming. This is a question in which all central station companies are interested and on which there are a few record cases and court decisions. It seems that the courts recognize a right of the central station to trim trees for lines to light streets, but no right in case the line is used to serve residence lighting, or other commercial work, and any property-owner can hold the company liable for tree-trimming in this latter case.

In Mississippi, Brahan vs. Meridian Home Telephone Co., 5250., 485, 1910, it was held that the cutting of trees in front of owner's lot without consent, placed the party so doing liable (under Miss. Code, 1906, Sec. 4927), to a penalty for the cutting or trimming. It is considered that the municipal authorities have the power to remove from the streets any obstruction of any kind interfering with lighting of the street and can direct the necessary tree trimming to any degree required.

It is usually held, however, that even in those cases where the right to trim is unquestioned, this right must be confined to reasonable and necessary cutting and trimming. Also in those cases where permission is secured to trim from the owner, such permit does not include a right to destroy trees or injure them beyond necessity. In the case of Barber vs. Hudson River Telephone Co., 105 N. Y., App. Div., 154, 93 N. Y. Supp. 993, 1905, it was so held and that for any excessive cutting beyond that necessary for protection of wires the offender is liable for trespass. In the case of Brown vs. Electric Company 138 N. Car., 533, 1905, it was held that shade trees standing along the sidewalk are the property of owner of the lot and the law protects them. They cannot be removed or injured except when necessary for use of streets as a public highway. The company in this case stood fine for damages on account of cutting down the tree standing on the sidewalk. In the case of Meyer vs. Telephone Co., 122 Iowa, 514, 1904, it was held that the damages that can be recovered for excessive and unnecessary cutting of trees when permission to trim is secured, are measured by the difference in the value of the owner's realty caused by the unreasonable cutting, and not for the effects of the entire cutting.

This subject is so interesting to central stations and telephone companies that it would seem worth while to have a standing committee on the associations of all sections of the country to collect information on the subject and put it in available form. W. H. WILSON.

Selection of Generating Voltage—Ans. Ques. No. 318.

Editor Southern Electrician:

In answering Mr. Carrigan's question No. 318 in the September issue on the selection of generating voltage, I call his attention to the fundamental conditions in the transmission of power economically, namely, if the frequency, the amount of transmitted power, and the percentage of power lost in the line remain constant, the weight of line copper varies inversely as the square of the voltage of the line. It is therefore desirable to use as high a voltage as possible that will allow the transmission of the power over the distance with a minimum cost for the plant. It is to be remembered that each system is a problem in itself and that the voltage must be selected with care. After a certain point is reached, the increase in investment of transformers, switching equipment, insulators, etc., with depreciation and repairs often more than offset the gain in conductors effected by the higher voltage.

In Mr. Carrigan's case the results from plants installed and operating under similar conditions makes it probable that 2,200-volt generators with 5 to 1 ratio step-down transformers at the points where the power is consumed will work out satisfactorily. The selection of generator sizes will depend largely upon the nature of the load and a load-curve showing the approximate demands should be at hand to give data on this point. For general service on an industrial system the delta connection of transformers is best suited, at least on the secondary side as it enables two transformers to act as spare for any one. That is if any one transformer fails the other two can carry the load connected in open delta.

The above selection of voltage checks up with a general rule for small and industrial power stations transmitting short distances as follows: The required line voltage is one-thousand volts per mile for the first three miles and four hundred volts for every additional mile.

ALBERT S. TEMPLE.

Insulation of Wires Through Trees—Ans. Ques. No. 312.

Editor Southern Electrician:

In answer to question 312 by H. T. G. appearing in the August issue of SOUTHERN ELECTRICIAN, it is impracticable to put any insulation on high tension wires which are carried through trees and expect the insulation to stand. The thrashing of the trees in stormy weather and the growth of the trees will change the conditions so that a line that may be clear of trees on a clear day will get into trouble on a stormy night. The only practical thing to do is to use some good form of tree insulator. These can be had for a very little money and are very effective and allow a tree to move so that there is no strain put on either. Devices for insulation of wires through trees are now available, and the writer will be glad to furnish additional information for praticular cases.

ENGINEER,
High Tension Electrical Specialty Co., Newton, Mass.

Operation of a Discharge Rheostat—Ans. Ques. No. 323.

Editor Southern Electrician:

It is a well-known electrical law that when a circuit, containing coils wound over iron cores, is broken or interrupted, the effect of the collapsing magnetism of the core in cutting through the coils of wire is to create an emf in the coil. It is for the purpose of absorbing the energy and effect of this emf that the discharge rheostat is used so as to prevent injury to the windings. THOMAS REILLY.

Fuses for a Two-Phase Three-Wire Motor—Ans. Ques. No. 323.

Editor Southern Electrician:

In regard to H. E. S.'s inquiry in Question 327 as to why the middle leg of his three-wire, 2-phase system requires a heavier fuse than either of the outside legs, I wish to call his attention to the following: In a 3-wire 2-phase system, the currents in all three wires are not equal. In the outside wires the currents are the same, but the middle wire carries the vector sum of the currents in the outside leads.

If "I" is the current in either outside wire, then the current in the middle leg would be $I\sqrt{2}$. If it is remembered that 2-phase currents are 90 degrees apart and that when alternating currents are to be added the angular difference between them must be taken into consideration, there should be no difficulty.

In this case, H. E. S. would have a right triangle with two equal legs representing the currents in the outside wires and the hypothenuse, or the current in the middle wire

equal to $\sqrt{2}$ times the value of either leg as can be seen by drawing the triangle and solving it. A. C. Kerr.

Dimensions of Wood Screws for Electrical Work.

Editor Southern Electrician:

Every electrician has, at some time in his experience, desired to know the dimensions of a wood screw of a certain gauge, or having a hole of a given diameter, he has wished to know what gauge of screw to use for it. The accompanying table was compiled by the writer for his own handbook,

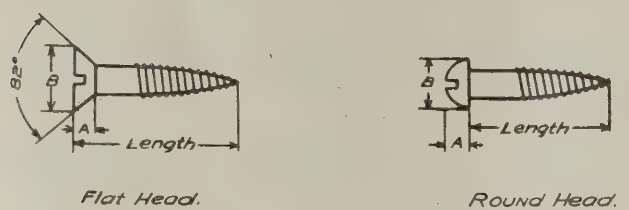


Fig. 1. Details of Flat and Round Head Wood Screws.

and gives these dimensions and other valuable information. To the writer's knowledge, this is the first time that all of this data has been gathered together in convenient form for the electrician's use.

Table Giving Dimensions of Wood Screws.

Screw Gauge Number	Diameter in Decimals	Diameter in Fractions	Nearest B & S Guage	Flat Head A	Flat Head B	Round Head A	Round Head B	Round Head Counterbore for Head		Clearance Drill No	Clearance Drill Diam	Greatest Length Obtainable
0	.05784	1/16–	15	1/16	7/64+							3/8
1	.07100	5/64–	14	1/16	9/64–				Depth of hole = height of head A.			1/2
2	.08416	5/64+	12	1/16	5/32+	1/16	13/64	7/32		44	.086	7/8
3	.09732	3/32+	11	1/16	3/16	5/64	13/64					1 1/2
4	.11048	7/64+	9	1/16	7/32–	5/64	13/64	7/32		33	.113	1 1/2
5	.12364	1/8–	8	1/16	15/64+	3/32	15/64					2 1/2
6	.13680	9/64–	7	5/64	17/64+	3/32	1/4	17/64		28	.1405	3
7	.14996	5/32–	7	3/32	19/64–	7/64	9/32					3
8	.16312	5/32+	6	7/64	5/16+	7/64	19/64	5/16		18	.1695	4
9	.17628	11/64+	5	7/64	11/32+	1/8	21/64					4
10	.18944	3/16+	5	7/64	3/8–	1/8	11/32	23/64		10	.1935	4
11	.20260	13/64–	4	1/8	25/64+	9/64	3/8					4
12	.21576	7/32–	4	1/8	27/64	5/32	25/64	13/32		7/32	.2188	6
13	.22892	15/64–	3	1/8	29/64	5/32	27/64					6
14	.24208	1/4–	3	9/64	15/32+	5/32	29/64	29/64		1/4	.250	6
15	.25524	1/4+	2	9/64	1/2	11/64	29/64					6
16	.26840	17/64+	2	5/32	17/32–	11/64	31/64					6
17	.28156	9/32	1	5/32	35/64+	11/64	1/2					6
18	.29472	19/64–	1	11/64	37/64	3/16	17/32	35/64			.302	6
19	.30788	5/16–	0	3/16	39/64–		17/32					6
20	.32104	21/64–	0	13/64	5/8+	13/64	9/16	37/64			.323	6
21	.33420	21/64+	0	13/64	21/32	13/64	19/32					6
22	.34736	11/32+	0	13/64	11/16–	7/32	5/8					6
23	.36052	23/64	00	7/32	45/64+	7/32	41/64					6
24	.37368	3/8–	00	7/32	47/64	15/64	21/32	43/64			.377	6
25	.38684	25/64–	000	7/32	49/64–	15/64	11/16					6
26	.40000	11/32–	000	15/64	25/32+	1/4	45/64					6
27	.41316	13/32+	000	15/64	13/16	1/4	23/32					6
28	.42632	27/64+	000	1/4	27/32–	1/4	47/64					6
29	.43948	7/16+	0000	1/4	55/64+	17/64	3/4					6
30	.45264	29/64	0000	17/64	57/64	9/32	25/32					6

DEALERS MOST OFTEN CARRY THE EVEN NUMBERED DIAMETERS IN STOCK.

Round head wood screws do not measure full length, running from 1-16 to 3-16-inch short. For example: A No. 4 x ½ round head wood screw measures about 7-16-inch long under the head, and a No. 20 x 2-inch measures about 1⅞-inches under the head.

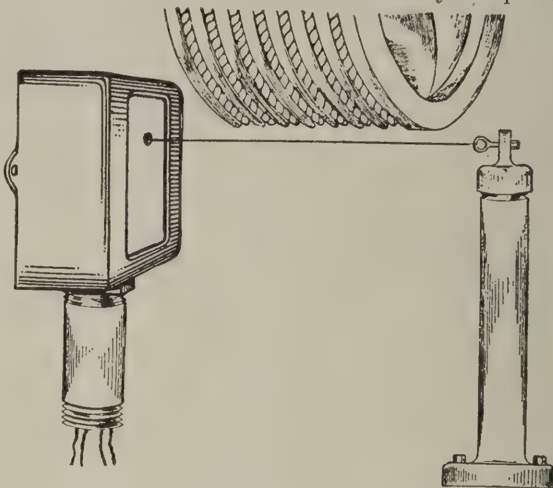
Wood screw diameters are measured by the American Screw Company's gauge, and range in size from No. 0 to No. 30. They range in length from 1-4-inch to 6 inches. The increase in length is by eighths of an inch up to one inch, then by quarters of an inch up to 3 inches, and by half inches up to 5 inches. Manufacturers' standards vary, but generally the threaded portion is approximately seven tenths of the total length. There is no standard number of threads per inch for the products of all manufacturers.

JOHN H. CONLEY.

Guarding Rope Drives.

Editor Southern Electrician:

Where rope drives are used, the breakage of one strand may cause such a snarling of the rest of the rope as to do considerable damage unless the machinery is promptly



Device for Indicating Broken Strands in Rope Drives.

stopped, which can only be done if the engineer is immediately notified of the defect in the rope. A tell-tale for detecting such a broken strand is easily made by stretching a wire close to one of the pulleys over which the rope runs. When the rope begins to fray, the loose strand beats against the wire and pulls an electric contact which rings an alarm bell. Albert Scheible.

Our Ancient Lineage.

If you want to know who were the first electrical engineers,
You must go back in history for years, and years, and years;
Back of the Roman empire, back of the siege of Troy,
Back of the time when Methuseleh was a sniveling little boy.

Now first I shall speak of Noah, and this is my excuse,
He was the earliest victim of an overload of juice;
Ham stumbled across him late one night when Noah was stiff and stark,
And from this we know that long ago they had blow-outs on the ark.

Then I might mention Moses, a tall and wiry cuss,
He was the first conductor, for he led the Exodus;
The Egyptians made resistance, but Pharoah's hosts were fooled
And one and all, as you may recall, were thoroughly water-cooled.

Then there's the sly old Serpent that in the Garden lay,
He was the first to wind a coil and there was hell to pay;
He led both Adam and Eve astray and this it was in, brief,
That led to the invention of the laminated leaf.

If you want to know who were the first electrical engineers,
You must go back in history for years, and years, and years;
Back of the tombs of Egypt, back of the temple of Pan,
To the day when the virgin Earth gave birth to the first of the race of man.

—The Jovian Bulletin.

New Apparatus and Appliances.

An A. C. Network Protector.

In the distribution of alternating current for light and power, it is the custom to generate at relative high voltages, distributing by ordinary feeders and mains to points adjacent to where the power is required. In communities where this network system of connection is desirable, continuity of service is of paramount importance but in this method of multiple connection, in case of one transformer burning out or otherwise causing a short-circuit on the system, the primary fuse of the defective transformer is at once blown, dropping the unit from the line which the remaining transformers connected to the network are called upon to pick up. In addition to this, the transformer will draw a short-circuit current from the secondary line which further increases the load which the remaining transformers must carry. On account of the drop in the line, the trasnformer nearest the short-circuit will take up most of the load which will cause the fuse on this transformer to blow, in turn shifting its load to the next transformer and so on, until the fuses of the entire number are ruptured and the service supplied from this branch of network of transformers interrupted. It is necessary before the service can be re-established to visit all the transformers and replace the fuses.

The Metropolitan A. C. network protector manufactured by the Metropolitan Engineering Company, of Brooklyn, N. Y., is designed to instantaneously disconnect a defective transformer, protecting the secondary network by preventing an overload on the remaining transformers and a consequent interruption of the service. In principle it is a series or current transformer, having three windings; a primary which is connected in series with the primary of the step-down or service transformer; a secondary winding which is connected in series with the secondary of the transformer, and a third winding which is of few turns and heavy wire so that the ratio of current that will flow in this coil when short-circuited and active is high as compared with current in the other coils. The primary and secondary windings of the protective device are wound with the same ratio of turns as the primary and secondary of the step-down transformer with which it is to be used and is connected in line with the step-down transformer, so that during normal operation the currents in the primary and secondary windings of the device oppose each other in direction, and as the ratio of the device and step-down transformer are equal the excitation in the two windings of the device are always equal, and being in opposition produce no current in the short-circuited coil.

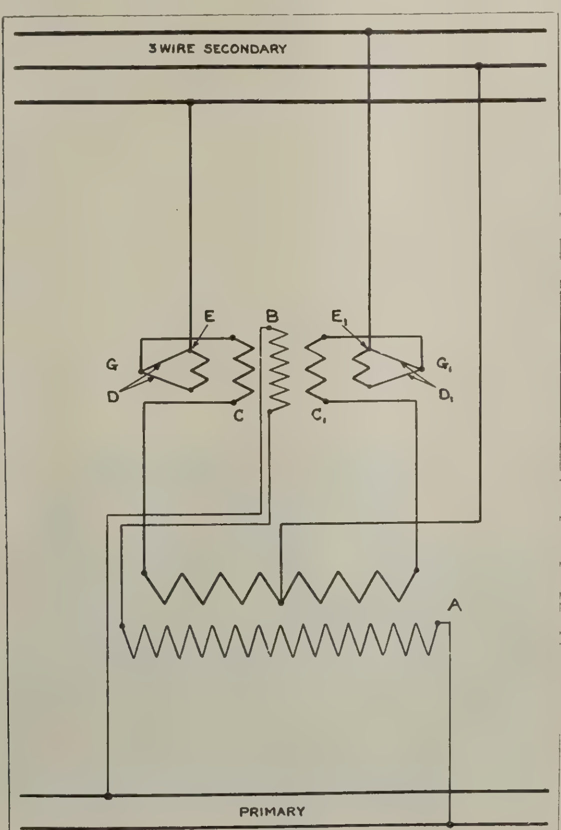


FIG. 1. DIAGRAM OF CONNECTIONS FOR PROTECTOR.

The connections of the device for a 3-wire network are shown in Fig. 1. The commercial transformer is shown at A, one terminal of the primary being connected in series with a coil B of the current transformer. The terminals of the secondary of the commercial transformer are connected each through its own coil C and C_1 on the current transformer. These latter coils connected to the middle point of the looped fuses D and D. One side of the fuses connected from E and E_1 to the outer conductors of the 3-wire network. The fuses D and D_1 act as a short circuit connection on coils F and F_1. The function of this combination is that under normal conditions, the currents in the primary B and the secondary coils C and C_1 having the same ampere turns and conneeted in opposition will neutralize each other so that there will be no m. m. f. circulating in the core of the current transformers to energize the coils E and E_1. This balance of conditions is maintained at all loads and is only upset by a reverse current flowing from the secondary network into the transformer as is occasioned by a short circuit in the latter. This condition immediately reverses the relative polarity of the coils C and C_1, thus energizing the core and causing a heavy short circuit current to flow through the coils E and E_1 by way of their short circuiting fuses D and D_1. The heavy short circuit current through the fuse immediately ruptures them and isolates the main terminals G and G_1. A supply of current sufficient to blow the V fuse is obtained with a reverse current in the secondary of about one-quarter full load current on the transformer, the defective transformer will thus be instantaneously cut out and disconnected from the line, allowing the remaining transformers connected to the network to continue their function, taking up the load of the defective transformer with no resulting interruption in the service. The device is made for all ratios and capacities of transformers, and for two or three-wire service.

Helion Iron and Heating Devices.

The statement that an electrically heated device can not be better than its heating unit is as true as the older statement that a chain is as strong as its weakest link. Much is claimed and apparently rightly, for the heating unit used in the irons and other heating devices manufactured by the Helion Electric Company of Newark, N. J. The unit for the Helion iron is made of a special resistance material moulded into a solid protective block, giving mechanical strength to the unit and insuring an even distribution

THE HELION ELECTRIC IRON.

of heat over the surface of the iron. The iron is shapely in design and has a provision for two heats, the switching from one to the other being accomplished by a button switch beneath the handle. Further, a provision is made for easily removing the heating unit for inspection or renewal.

The toaster made by this company uses a heating unit made up of Helion, a resistance material capable of withstanding a high temperature without deterioration. It is also of graceful design and lights up with a certain glow that gives it the name of a luminous toaster.

The Storage Battery Railroad Train.

Wednesday, September 25th, marked a new era in electrical transportation, it being the date of the first run of a complete railroad train by storage battery power under the multiple unit control of a single operator. The three car train itself was constructed for the "Unidos Habana" of Cuba for service on that island. The trial trip, on which a number of the country's most prominent railroad men were present, was made from the Pennsylvania Station in New York City to Long Beach, L. I., and carried in the three cars approximately one hundred and forty passengers, making the trip of 25 6/10 miles each way in respectively 56 and 52 minutes.

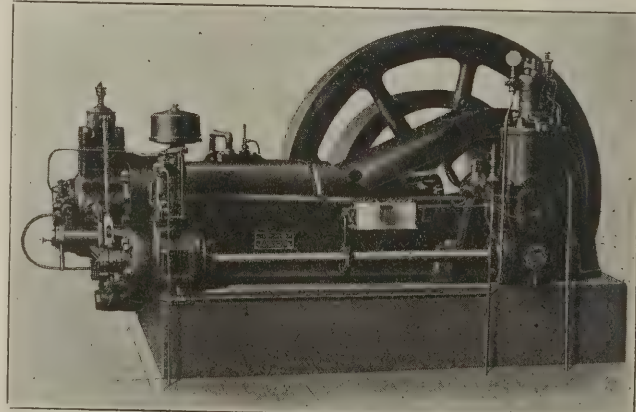
This achievement has been made possible by the development of the direct current Diehl motor manufactured by the Diehl Manufacturing Company of Elizabethport, N. J., the Edison storage battery and a clever system of the multiple unit control evolved by the Cutler Hammer Co., these three necessary factors being combined as a whole by the Federal Storage Battery Car Co., of Silver Lake, N. J.

The type of car used in the trial run has a measurement of 38 feet, 5 inches long. It is equipped with vestibules and provided with four double seats and four end seats, accommodating 40 passengers. The trucks of the car are of the four-wheel type, eight wheels to a car, with two 10-h.p. motors mounted on each truck. These motors are series wound and the normal speed ratings are 800 and 950 rpm. At 200 per cent overload they will develop approximately 62½ per cent of their normal speed and at 100 per cent overload 70 per cent. Their weight varies from 350 pounds in the smaller sizes to 1,190 pounds in the larger. They develop a temperature rise under normal load for one hour enclosed floor test of 45 degrees C. The standard railroad guarantee giving a latitude of as high as 75 degrees.

The energy for operating these motors is derived from a 200-cell storage battery of the Edison A-6 type located under the seats of the car. During the trial run of the three-car train, the start was particularly noticeable, for the very easiness with which it glided out of the station, there being a total absence of a starting jerk. Acceleration of speed was gradual at the start, but increased very rapidly. A high speed was maintained for a considerable period, at times being as high as 35 miles an hour. The road to Long Beach is particularly adapted to such a test, being comparatively level with the exception of one stretch which grades heavily, rising from the Pennsylvania tunnels to the level of Long Island City. The motors took this grade at about 100 per cent overload.

Otto Crude Oil Engine.

The development of an internal combustion engine which will operate successfully and with the greatest possible economy not only on crude oil, but also on the residual products obtained in refining crude oils, as well as on the by-products of gas and coke manufacturing plants, is of interest to every one interested in the production of power at the lowest possible cost. An engine of this type is represented by the horizontal Otto crude oil engine operating on the Diesel method of fuel injection and combustion, as shown in the illustration. It is said to be the first horizontal type built in the United States. The advantages which explain the phenomenal success of this type of engine are due to an entirely new principle of handling liquid fuels of low degree, such fuels as have not heretofore been converted into power without the use of expensive and complicated auxiliary apparatus for the purpose of vaporization. The Otto crude oil engine uses these fuels in their simplest, safest, least expensive and most generally available form, and its efficiency is claimed so far ahead of that of any other prime mover, not only steam, but also any ordinary type of internal combustion engine, that the degree of economy obtained in employing these cheap fuels



OTTO HORIZONTAL CRUDE OIL ENGINE.

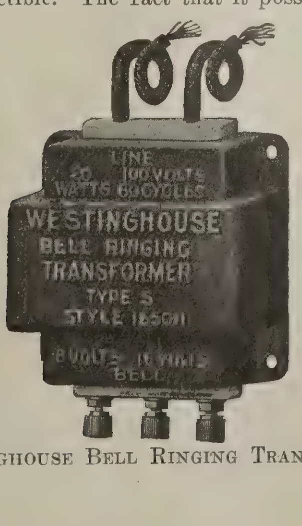
is truly remarkable. Crude oils and residual oils obtained in refining mineral oils of all kinds are available at prices ranging from 2½ to 4 cents per gallon, according to the distance from the oil fields to the destination of shipments. Considering that the engine develops a brake horsepower hour on 1/15 of one gallon of these fuels, it will be seen that the fuel cost per brake horsepower per hour is from 1/6 to 1/4 of a cent.

The horizontal Otto crude oil engine is of the single acting type and operates on the four-stroke-cycle principle, invented by the late Dr. Nicholas A. Otto. Every kind of low-grade fuel is used, such as crude oil, gas oil, solar oil, tar oil and similar oils, and with the same degree of reliability and economy. The cycle of operations is as follows: During the first outward stroke of the piston, a charge of pure air is admitted into the cylinder through the inlet-valve. This air is compressed during the succeeding inward stroke until its temperature exceeds the temperature at which the fuel ignites. The latter is injected into the heated air at the end of the compression stroke, ignited spontaneously by the highly heated air in the cylinder produced by the compression stroke, and burns steadily for a part of the expansion stroke. Sudden variations in pressure are avoided in this engine. The spent gases are expelled through the exhaust valve and port during the succeeding return stroke. The four-stroke cycle being thus completed, its functions are continuously repeated.

The Otto crude oil engine is in no sense an experiment. On the contrary there are today in use in Germany and other European countries between 33,000 and 36,000 horsepower of Otto-Diesel engines. This same type of engine has been built at the Otto works in Cologne for many years. The first model was exhibited twelve years ago at the Paris exhibition. It is interesting to note that while the Otto Company is the first to build the horizontal type of Diesel engine in this country, they have also had first honors in developing the original gas engine in 1876—the first anthracite producer in 1903—the first alcohol engine in 1906.

Westinghouse Bell Ringing Transformer.

The use of bell ringing transformers has become so popular that the Westinghouse Electric and Manufacturing Company has placed on the market a new transformer of this type, built according to the design of its well-known Type S distributing transformer. It is very light in weight, compact in size, absolutely fireproof, and practically indestructible. The fact that it possesses such characteristics enables it to be mounted in any out of the way place as it requires no attention whatever after its installation and should last a lifetime. It will deliver on open circuit, 8, 16 or 24 volts, and fully loaded 16 volts. It is particularly useful for apartment houses and public buildings.

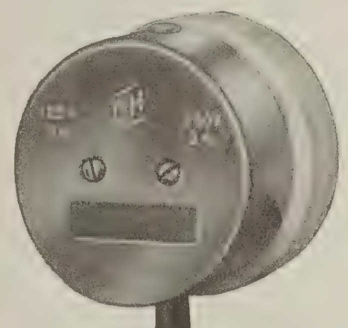


Westinghouse Bell Ringing Transformer.

Rubber covered primary leads are brought out of the top of the case through a porcelain bushing and are left of sufficient length to permit connection to the lighting circuit. Binding posts are provided, as shown in the picture, for the bell circuit, and the transformer is mounted by lugs cast on the case for this purpose. These lugs are so arranged that an air space is provided between the transformer and the wall.

Cutler-Hammer Circular Base Surface Switch.

To the rectangular base surface switches designed particularly for moulding work, a new type of circular base surface switch has been designed by the Cutler-Hammer Mfg. Co., of Milwaukee. This new switch is made in two styles—No. 7107 having a label holder and No. 7108 having a plain cap without label holder. Where a number of switches are located at one place the 7107 switch is adapted as each may carry a label indicating the circuits or lamps controlled. The depth of this new switch is only 1¾ inches and the diameter of the cover or cap, which is of polished nickel, is 1⅞ inches. The circular porcelain base is like those of other surface switches but the back is hollowed out for circular loom on concealed wiring or for surface use.


The No. 7107 C-H Push Button Surface Switch.

One of the particular features of this switch is that there is no protruding button which may be broken off or, by turning the wrong way, be removed and lost. The ingenious mechanism makes it possible to eliminate this rotating button and substitute the straight push bar which is a part of the mechanism and can not be removed and since it does not protrude can not be accidently knocked off as easily as the button. The push bar is indicating as it has a light button at one end and a black button at the other. Pressing the light button means the circuit is closed.

The rating of the 7107 and 7108 switch is 5 amp. 125 volts, 3 amp. 250 volts (National Electrical Code Standard) same as the rectangular base C-H surface switch for molding work. The bases of the latter switches are now made of a single piece in place of the two pieces used formerly.

Western Electric's New Indianapolis Home.

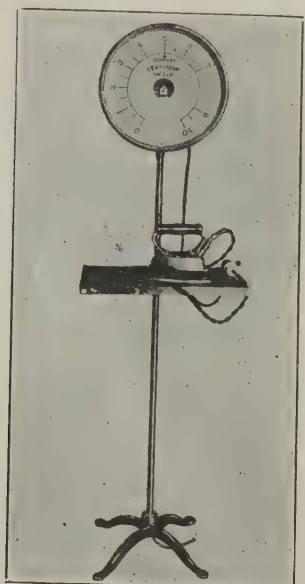
The Indianapolis office of the Western Electric Company is shortly to move into new quarters which have been leased at 121 South Pennsylvania street. The new building, which contains 31,000 square feet of floor space and is

five stories high, is better adapted to the needs of the local organization than the old building which it has occupied for the past five years.

A retail store is to be opened on the ground floor of the new house, for selling everything electrical, for business, factory and home use. The store will be but two squares from the principal retail street of Indianapolis, Washington street, and will therefore be quite convenient for the retail trade. The remaining floors will be used for offices and warehousing. There will be complete stocks of electrical apparatus and supplies. It is intended to have the new building serve as a distributing point for material intended for the use of the Central Union Telegraph Company.

A Meter That Shows Cost to Operate Electrical Devices.

A new meter intended for use in the central station display room has been put on the market by the Harbrook Service Company of Pittsburgh. The meter, called the Donkin Cent-Hour Meter, is the invention of Mr. William A. Donkin, contract agent of the Allegheny County Light Company. Its purpose is to give an authoritative answer to the universal question "How much does it cost to operate?" When any current consuming device is connected to the meter, the hand points instantly to the number of cents per hour that it costs to operate. It is especially useful in demonstrating to a customer the cost of current for a device that operates at more than one heat.



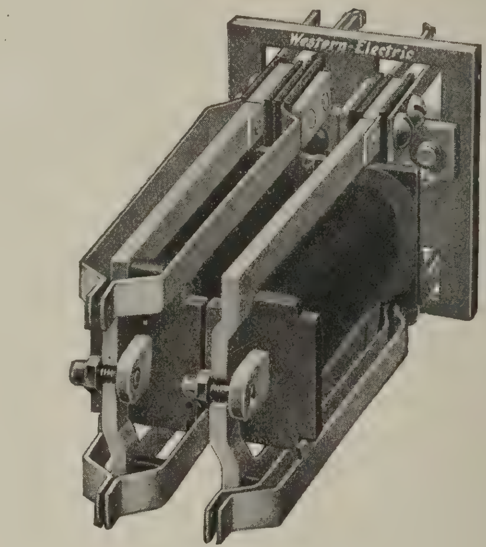
THE CENT-HOUR METER.

The meters are callibrated and the reading of the dial is made to correspond to the central station's rate. The mechanism is similar to that of a regular watthour meter. The meter is mounted on a floor pedestal and is provided with a stand to hold the device being measured for current consumption. It has been shown by actual test that this method of answering the all-important question has more weight with the customer than a verbal answer and that the Cent-Hour meter is an important factor in making sales.

A New Telephone Relay.

The engineering department of the Western Electric Company has designed a new telephone relay, which is of the type known as the "line and cut-off" and primarily for switchboard equipments.

The maximum line resistance over which the new relay can be adjusted to operate satisfactorily is greater than that over which most other relays will work. As it will meet the adjustments of the No. 163 type, it may be used in old equipments where the new and old must align with each other, although originally designed for new installations. This new No. 194 type ready is said to possess



A NEW WESTERN ELECTRIC RELAY.

many features which stamp it as the superior of the No. 163. There are no knife-edge armatures, contacts are more accessible, number of parts is smaller, it occupies less space and can be mounted on a narrower mounting, all iron parts are electro-galvanized and the line part is of the same mechanical design as the cut-off part of the relay. The windings are of black enameled wire; and atmospheric conditions, such as high temperature and excessive humidity have practically no effect on its operation. The new relay is light and little liable to jar out of shape and adjustment. The springs and terminals are well separated, making adjustment and inspection simple and expeditious.

Reco Color Changing Reflectors.

Only within recent years has the outdoor advertiser began to realize that night advertising is more remunerative than day. Painted or poster bulletins on walls or wire signs, that only show in the daylight, have been found to bring handsome returns in the shape of publicity. Nevertheless, it has been tested, tried and proven that these same boards or signs, if illuminated, will increase the publicity and advertising returns. To secure a proper, effective and economical system of reflection, has been the occasion of much experimental work and thought and many forms of reflectors have been tried. The Reynolds Electric Flasher Mfg. Co., of Chicago and New York, announce a design which is highly efficient, economical and bright light-giving. It is lined with white poreclain and evenly diffuse the light over every part of the board. By means of a flasher, which is furnished with a weatherproof cabinet, attachable to the back of any sign, it is possible to secure an innovation in bill board lighting, color-changing effects, a billboard changing from white to pink to red to white, etc., renders an attraction which is bound to increase the advertising value of a bill board.

Southern Construction News.

This department is maintained for the contractor, dealer, jobber, manufacturer and consulting engineer. The material is obtained from various sources and includes the latest information on new Southern engineering and industrial enterprises. We ask the co-operation of new companies by furnishing authentic information in regard to organization and any undertakings. We also invite all those who desire new machinery or prices on electrical apparatus to make liberal use of this section. No charge is made for the services of this department. Every effort is made to avoid errors in any item, and if such occur, we want to know about them.

ALABAMA.

BESSEMER. The Birmingham Railway Light & Power Co., has been granted a franchise to erect a street railway line to the Woodward furnaces of the Woodward Iron Co.

BIRMINGHAM. The Alabama Interstate Power Co., has awarded a contract to McArthur Bros., of New York, to construct a dam at Lock 12 on the Coosa river 40 miles from Birmingham. A dam 1,550 feet high will be constructed and a power house. The power house will contain six single running verticle water turbines with space for two additional ones, the turbines having a capacity of 105,000 H. P. The generating equipment of 65,000 K. W. will be installed. The transmission will be at 110,000 volts and lines led to Birmingham and other cities. The New York office of the company is at 100 Broadway with the Alabama Traction, Light & Power Co., of which W. W. Freeman is managing director. Mr. M. Webb Offut is assistant general director and located at Birmingham.

FLORIDA.

BRADENTOWN. Bonds to the extent of $75,000 have been voted for an electric light plant. Extension to water works, sewerage and drainage systems.

DAYTONA. The Daytona Public Service Co., has been chartered with a capital stock of $300,000 to build an electric railway. The officers are F. M. Conrad, president, and T. E. Fitzgerald, secretary and treasurer.

INVERNESS. The Inverness Power Co. has applied for a franchise for an electric light and water works system.

NEWBERRY. The city will vote on a bond issue of $30,000 to construct an electric light plant.

ST. PETERSBURG. It is understood that a new street lighting system is to be installed and that the St. Petersburg Investment Co., has a contract for lighting the city. This company will build a new power plant.

GEORGIA.

ALBANY. Bids are now open for material on the equipment for a street railway system. One 150 K. W. direct current generator; 1,200 H. P. four-valve engine; four miles of trolley material; 375 tons of 60-pound steel T rail, 45 tons of 70-pound steel T rail. Information can be obtained from J. C. Fulford, secretary and treasurer.

DALTON. The city council has entered into a contract with the Georgia Railway & Power Co., to supply power to the city. A franchise has been granted the company to extend its lines into Dalton.

DECATUR. The Georgia Railway & Power Co., will construct a sub-station on College Ave., Decatur, from which electrical energy will be distributed for Decatur.

EATONTON. The Solomon-Norcross Co., of Atlanta, has been engaged to prepare plans for a municipal lighting and power plant.

GRANTVILLE. A contract has been awarded the J. B. McCrary Co., for the installation of an electric light system.

HINESVILLE. The Flemington, Hinesville & Western Railway Co., has been incorporated by J. R. Ryan, T. S. Layton, J. B. Frazier, and others of Hinesville. A 25-mile interurban railway to connect Flemington, Hinesville, and Glennville is to be built. J. B. Way is president.

LAVONIA. The town council has given a franchise to J. B. McCrary & Co., to install an electric light system.

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KENTUCKY.

ADAIRSVILLE. The Adair Light & Heating Co., has been organized with a capital stock of $5,000. The incorporators are M. E. Orendorff, B. M. Pulliam, G. H. Smith and J. B. Fisher.

BORYDON. Bonds to the extent of $8,000 have been authorized for the installation of an electric light and power plant.

CLAY. The Clay Light & Ice Company is installed an electric light plant and proposed also to install a ten ton ice plant to be put in operation by May 1st. Overhead line material and inside fixtures are desred and proposals for same can be addressed to C. R. Clark, general manager.

COVINGTON. The cty commissioners of Covington are considering the installation of ornamental street lighting along York Street and Boulevard.

FRANKFORD. A new street lighting system on Main and St. Clair Streets is planned by the Kentucky Public Service Co.

HARDING. A small lighting plant will be installed and prices on machinery is desired. The mayor can give information.

LEXINGTON. An arc lighting system is to be installed on the ground of the Kentucky State University.

LOUISVILLE. The Louisville Lighting Co., is to extend its transmission lines to St. Helena, seven miles south of Louisville. It is also planned to erect and maintain ornamental street lamps on Main street.

LOUISVILLE. The Louisville Railway Co. has commenced work on their shops. Three buildings will be erected at a cost of $150,000, one of these buildings being used as an electric repair shop.

PARIS. The property of the Paris Gas & Electric Co., has been purchased by the Light & Development Co., of St. Louis Mo. C. L. Steenbergen is general superintendent being retained by the new company. H. Wurdack, of St. Louis, Mo., is president of the light and development company.

PEMBROKE. Franchises have been secured by the Pembroke Water, Light & Power Co., to operate an electric light and power plant and water works system.

PERRY. W. J. Devaun is completing an electric lighting plant and expects to put the system in operation shortly.

RICHMOND. The Dix River Power Co. is preparing to construct a hydro-electric power plant on the Dix river near Richmond. L. B. Herrington is president. Brown & Clarkson, Washington, D. C., are engineers.

LOUISIANA.

MORGAN CITY. J. W. Taylor, of New Iberia has been given a contract to construct a municipal electric light plant.

NEW ORLEANS. The Electrical Development Co., has been incorporated with a capital stock of $7,000. The officers are Lyman C. Reed, president; G. H. Holmes, vice-president, and C. B. Murphy, secretary and treasurer.

NEW ORLEANS. The Louisiana Interstate Mineral Co. has been organized to develop certain holdings in Smith and Jasper counties in Mississippi. It is understood that Northern capitalists are organizing the company and that it is capitalized at $3,000,000 and holds something like 15,000 acres of timber land rich in mineral deposits. Factories are to be erected and a fertilizer plant capable of producing 5,000 tons per day. A dam will be constructed and a power house erected capable of developing 10,000 H. P. C. S. Peterson, formerly of New York City, is president; A. F. Peterson, of Rew, Pa., is vice-president; Clarence L. Foretich, of Mobile, Ala., is secretary; T. B. Burke, of Eau Claire, Wis., is treasurer.

SHREVEPORT. It is reported that the Shreveport Gas, Electric Light & Power Co., and the Caddo Gas & Oil Co., have been purchased by the Southwestern Gas & Electric Co., of Delaware. This company is also said to have acquired the property of the Texarkana Gas & Electric Co., of Texarkana, Ark.

ST. BERNARD. A franchise to supply electric light and gas service has been applied for by the New Orleans Railway and Light Co.

NORTH CAROLINA.

CHARLOTTE. The R. T. Auten Electric Co., has changed its name to Westchester Electric Co.

GASTONIA. An issue of bonds to the extent of $2,500 is to be submitted to a vote. The purpose of this issue to make improvements to the electric lighting system.

SOUTH CAROLINA.

CHARLESTON. The Charleston & Summerville Interurban Railway Co., has been chartered with a capital stock of $500,000

to build an electric road. This road will extend between Charleston and Summerville, a distance of 20 miles. The officers are J. L. David, president; D. W. Hughe, secretary; W. M. David, treasurer.

EDGEFIELD. The city will vote on a $5,000 bond issue to build an addition to the electric light plant.

GREENVILLE. The Cedar Falls Light & Power Co. have been given a charter to do a general lighting and power business.

KINGSTREE. The Kingstree Electric Light & Ice Co., is planning to erect a power house. A 75 K. W. generator and a 15-ton ice machine will be installed. The president of the company is P. G. Gourdin.

PENDLETON. The Pendleton Electric Light Co., has been granted a charter with a capital stock of $5,000. The incorporators are E. N. Sitton L. E. Sitton and C. S. Chreitzberg.

SENECA. The Seneca Light & Power Co., which has been recently organized, is to build a dam across the Coneross Creek at Fitzgerald Shoals near Seneca. An electric light and power business will be done in Seneca.

SPARTANBURG. The Spartanburg Railway, Gas & Electric Co., is planning to construct additional hydro-electric plants. Plans are not yet completed as to these developments.

STOREVILLE. J. L. Jackson is to construct a dam on Rocky River to develop 150 horsepower. The engineer in charge is A. J. Newell.

THOMASVILLE. The Jewell Cotton Mills desired to secure second-hand electric motors of two to three horsepower, 550 volts three-phase, 60-cycle, 1800 R.P.M.

TENNESSEE.

CHATTANOOGA. Plans are underway for the installation of an ornamental street lighting system in Chattanooga. One hundred and fourteen inverted lamps are to be installed and maintained by an underground system. The Retail Merchants' Association of Lookout City will have charge of the work.

CHUCKEY. The Chuckey River Hydro-Electric Co., has been incorporated with a capital stock of $25,000. A hydro-electric plant will be constructed on the Nolachuckey River in Green County. The incorporators are B. M. Weaver, J. L. Stuart, M. T. Heisey, S. K. Varnes, all of Harrisburg, Pa., and Dr. J. F. Arnold of Green County.

CLINTON. The Clinton Electric Light & Power Co., through a fire suffered a loss of $5,000 by the destruction of engine and generators.

GAINESVILLE. The Public Assurity, Fidelity & Trust Co., of Dallas, is said to have taken over the proposition of constructing an interurban electric railway between Gainesville and Sherman. C. L. Waefield of Dallas has charge of the project.

LIMESTONE. The Chuckey River Hydro-Electric Co., has been incorporated by J. F. Arnold of this place and M. T. Hersey, V. M. Weaver, J. L. Stuart and Samuel K. Varnes, all of Harrisburg, Pa. A power plant will be constructed on the Nolochuckey River.

SELMER. The Selmer Eletric Light & Gin Co. has been incorporated with a capital stock of $5,000. The officers are C. B. Stedman, president; F. S. Hendrix, vice-president; Albert Gillespie, secretary and treasurer, all of Bethol Springs. The general manager is W. M. Brown, of Selmer. H. A. Robinson is manager of the plant.

BOOK REVIEWS.

DESIGN OF ELECTRICAL MACHINERY, Vol. 3.—Alternators, Synchronous Motors, Rotary Converters, by William T. Ryan, Assistant Professor of Electrical Engineering, University of Minnesota. Published by John Wiley & Sons, New York City. 129 pages, 104 illustrations. Price $1.50 net.

Volume 3 under the above heading is a very interesting treatise on design for use by students in electrical engineering courses. Mr. Ryan, through his experience in teaching the subject, has been able to present this matter in a form which makes it not only decidedly practicable for universities and colleges but for every designer who is interested in electrical machinery. He has departed from the old idea that electrical apparatus can be designed by any set rule and has followed the method which the student will find is required of him should he become connected with the design department of a manufacturing company. The volumes are not filled with derivations of formulas and the origin of well-known laws, which can be found in numerous other available works of authority. The volumes therefore are written briefly and take up the subject in a manner which will be pleasing to the engineer who has not yet found a work which he can use without considerable study in selecting those parts which are of practicable value. We feel sure that any one who invests in the complete set of three volumes will be more than pleased and find them of decidedly practical use.

QUESTIONS AND ANSWERS ON THE NATIONAL ELECTRIC CODE, by T. S. McLoughlin. Published by the McGraw-Hill Book Co., New York City. 210 pages. Price $1.00.

This work has been written as a key and index to the National electric code so as to enable any one interested in electrical construction to interpret the electrical code according to standard practice by the best of engineers and get from some of the complicated constructions in the code their true and intended meaning. Eight sections are treated and in each of the sections questions are given with answers, the questions being based on problems that may come up in practical work and the answers refer to the rule under which the problem comes. The sections treated are as follows: generators in general; transformers; outside work; signaling systems; arc lamps and incandescent lamps; inside work; electric railway systems; marine work; and National code requirements on wire and material. Several original tables are included in the back of the book giving specifications of material under various conditions. The book is bound in red flexible leather, pocket size.

WIRELESS TELEGRAPHY AND WIRELESS TELEPHONY, by Charles E. Ashley and Charles B. Haywood. Published by American School of Correspondence, Chicago. Price $1.00.

This is a new work containing 114 pages and treats in an understandable way the science of wireless transmission of intelligence A section on wireless telephony covers radiophone, selenium cells; photophones; light telephony; telephony by means of hertzian waves; nature of a high frequency telephone current; oscillation generators; telephonic control of oscillations; transmitting circuits; receiving arrangements; two way transmission; and systems of radiotelephony.

This work in its make-up is similar to many other volumes published by the American School of Correspondence and has behind it their reputation which assures every reader that the material it contains is up-to-date and written by the best of authorities.

ALTERNATING CURRENT MACHINERY, by William Esty, professor in charge of Electrical Engineering, Lehigh University. Published by American School of Correspondence, Chicago, Ill. 467 pages, with numerous illustrations. Price $3.00.

In the publication of the above volume, the American School of Correspondence has done two things. It has presented a work on A. C. machines and systems that covers in an adequate way the essential points and yet is brief; it has presented to the student not well up on mathematics a volume that can be read, appreciated and best of all understood and applied. It is written by an unquestioned authority and represents one of the best works on alternating current subjects yet published.

The nature of the treatment given the subject and its scope can best be judged from the contents which are in brief as follows:

ALTERNATING CURRENT PRINCIPLES.—Alternating electromotive forces and currents. MEASURING INSTRUMENTS.—Indicating instruments and integrating instruments. ALTERNATORS.—Polyphase alternators and systems; measurement of power; armature winding. COMMERCIAL TYPES OF ALTERNATORS—revolving armature and revolving field; economy factors; conditions affecting cost; power losses and efficiency; rating and overload capacities; testing. SYNCHRONOUS MOTORS—testing. TRANSFORMER—connections; in polyphase systems; practical considerations; commercial types; tests. CONVERSION OF A. C. TO D. C. rotary or synchronous converter; rotary converters in practice; testing; motor-generators; INDUCTION MOTOR—comparison of synchronous motor and induction motor; induction motor tests. SWITCHBOARD AND STATION APPLIANCES—switchboards; special switchboard apparatus; circuit-interrupting devices; lightning arresters. APPENDIX—parallel operation of alternators.

LIGHT—ITS USE AND MISUSE, is a primer on light and illumination, published by the Illuminating Society, 29 West 39th Street, New York, and has already gone into a second edition. Written in a clear and comprehensive manner for popular reading, this little pamphlet has met with immediate favor. It has occasioned considerable complimentary criticism from people who are generally supposed to have little or no interest in the subject of lighting. From the heads of engineering and physics departments of schools and colleges the society has received numerous letters of commendation together with requests for quantities of the primer for distribution to students. Architects, engineers, oculists, merchants, and others have also expressed their appreciation of the publication. Several lighting companies are planning to issue it to their customers. One large manufacturing company in London has cabled for permission to print and distribute a large edition in Europe. It is not unlikely that the primer will go into many editions.

PERSONALS.

MR. JOHN A. BRITTON, vice-president and general manager of the Pacific Gas and Electric Company, and member of the executive committee of the National Electric Light Association, delivered an illustrated lecture on the system and service

of the company, and on the remarkable developments in electrical power transmission on the Pacific coast, in the main auditorium of the engineering Societies building, 29 West 39th street, New York City, on Thursday, November 14.

This system, the largest in the world, serves more than half the population of the state of California, some 30,000 square miles, from which it derives an income of about $15,000,000 annually. In engineering achievement, comprehensiveness of service and distribution, and the successful solution of the problems of great modern public utilities, the system is unequaled. Its circuits reach from the Sierras to the Golden Gate—nearly 250 miles.

MR. CLAUD WARRINGTON who formerly represented Macbeth Evans Glass Company in the Southern States, with headquarters at Atlanta, has resigned from that company to become special southern representative of the Haskins Glass Company, with headquarters in New Orleans, La. Mr. Warrington has many warm friends in Atlanta and throughout the south who wish him all success in his new connection.

MR. RALPH U. FITTING formerly with the engineering department of the Electric Bond and Share Company for four and a half years, has been engaged by Harris, Forbes & Co., New York bankers, as engineer. At the time of his resignation he was assistant chief engineer and had charge of all the gas construction work done by the company. Previous to graduation from Stanford University in 1906 he had been connected with the gas department of the Independent Gas & Electric Co., of San Francisco; the engineering department of the Northern Pacific Railway Co., at Tacoma, Wash.; the transmission line construction of the Puget Sound Power Co. on the Electron Development; Tacoma sub-station construction for the Tacoma Railway & Power Co., and the drafting department of the Pacific Gas and Electric Co. in San Francisco. After graduation he became identified with the gas business again and accepted a position as draftsman to the Portland Gas Co., of Portland, Ore., and held the position of superintendent of distribution when he resigned about two months before coming to New York.

MR. CHARLES F. HOWE, formerly engineer of the Central Georgia Power Company and its allied interests, has resigned his position to engage in consulting engineering, with offices in the Georgia Life building, Macon, Ga. Mr. Howe has been actively engaged in the investigation and development of the water powers of the South, particularly those of Georgia and Alabama, for the past ten or twelve years, and is probably the most widely informed man as to the commercial value and possibilities of the development of the rivers in the Southern states of any one person.

It was through his instigation and work that the development has been made of the Ocmulgee River near Jackson, Ga., involving the construction of the gravity dam 100 feet high, 1,800 feet in the extreme length, developing twenty-six thousand primary horsepower, and its transmission to Atlanta, Macon and other nearby cities. Mr. Howe was appointed chief engineer of this company at its organization early in 1907, and has since been actively engaged in the developmen tof the Central Georgia Power Company and its allied interests, the Macon Railway & Light Company, the Central Georgia Transmission Company, and the Flint River Power Company. He is retained by these companies as their consulting engineer.

INDUSTRIAL ITEMS.

BASELER & HEINEKEN, INC., of Camden, N. J., has recently secured the services of N. E. Funk as general sales manager. Mr. Funk has for a number of years been connected with engineering work leaving the engineering department of the Philadelphia Electric Company to accept his present position. The above company whose sales policies he will be responsible for is manufacturers of a large line of panelboards, switchboards, knife switches, combination switches, steel and iron boxes, specialties, etc. W. M. Reay & Company, of Norfolk, Va., and L. M. Robertson, of Birmingham, Ala., are sales agents in the South where a rapidly growing business is reported.

J. G. WHITE & CO., INC., announces that it has been the opin ion of a number of officers and directors that the engineering-construction department and the operating department of the company could be conducted with greater efficiency and profit if separately incorporated. In view o fthe large and increasing volume of engineering and construction work now being undertaken by the company, additional capital could be advantageously used if the engineering-construction department and the operating department were separate intities. The Board of Directors deem it advisable, therefore, that two new corporations be formed, one to be known as The J. G. White Engineering Corporation, to take over the engineering-construction department of this company, and the other to be known as The J. G. White Management Corporation, to take over the operating department of this company.

The firm of J. G. White & Company was established in New York in 1890, after Mr. White had sold to the Edison United Manufacturing Company the Western Engineering Company, of Nebraska, of which he had been president from the time of its formation in 1887. The business was first carried on under firm name, and later as the White-Crosby Company, and still later as J. G. White & Company, a New York corporation. These led up to the date of the formation of J. G. White & Company, Inc,., under Connecticut charter in 1903. The scope and importance of the business has been gradually extending from its original inception.

The aggregate cost of work under construction in the hands of the engineering-construction department during the year to date has been about $28,000,000. It has required many different types of engineering service and has been distributed throughout thirty different states and Canada. It covers the complete rehabilitation of several existing public service properties, the construction and equipment of two high-speed interurban electric railways, one of which—the Oakland, Antioch and Eastern—runs from Oakland eighty-four miles into the Sacramento Valley, passing through a tunnel two-thirds of a mile long into Shepherd's Canyon. The Company's work also includes engineering for the drainage of 118,000 acres in Florida, and the design and construction of a 124-mile 12-inch natural gas pipe line from Bakersfield to Los Angeles, in California, which line is noteworthy not only because it is the first to be put down in California, but because it is to operate at a pressure of 450 pounds per square inch, the highest ever yet employed.

The hydro-electric developments under construction include some of the most important in the United States, and have added to the prestige and maintained the leading position of J. G. White & Company as builders of American water powers. These have included the development of the Big Sandy, at the foot of Mount Hood in Oregon; the development of the Deerfield, an important tributary of the Connecticut river; the Savannah river development, near Augusta, Ga.; the Broad river near Columbia, South Carolina, and the development of the Oconee in the mountains of eastern Tennessee. In addition to these, there are also the San Joaquin development in California, and the development of the Beauharnois, a tributary of the St. Lawrence, in Canada; the aggregate capacity of these water powers being approximately 250,000 horsepower.

THE NATIONAL TUBE CO., of Pittsburgh, Pa., has issued catalogue No. 11 on national pipe. Since the organization of the National Tube Company experiments have been conducted with the object of producing a grade of steel which will successfully fulfill the great demands made upon pipe by modern usage. One process which has become known as "Spellerizing" has been developed for the smaller sizes which, after several years actual trial under service conditions, is said to be giving the most encouraging results.

"Spellerizing" is a method of treating metal which consists in subjecting the heated bloom to the action of rolls having regularly shaped projections on their working surface, then subjecting the bloom while still hot to the action of smooth faced rolls and repeating the operation, whereby the surface of the metal is worked so as to produce a uniformly dense texture better adapted to resist corrosion, especially in the form of pitting.

Inasmuch as this process is entirely mechanical and does not in any way depend upon skilled labor beyond keeping up the machinery involved, uniform treatment is assured. The "Spellerizing" process is applicable to the smaller sizes of pipe viz: 4 inches and under, although it is possible in special cases to "Spellerize" pipe a few sizes larger than 4 inches. This process is, of course, most desirable in the smaller sizes on account of the thinner walls. The larger sizes, owing to their thicer walls, do not require so much extra work of this character; but by other means in blooming and rolling these thicker plates are produced of such uniform quality that the pipe made from them is said to show decided superiority over pipe made from ordinary steel skelp.

THE GENERAL ELECTRIC COMPANY announces that owing to certain legal complications which occurred at the time the Holophane Sales Department was taken over, it became necessary to use another name for the joint organization of Holophane and Fostoria lines. For this reason the word "Nelite" was adopted. The legal obligations have been overcome, and on October 21 it was decided to resume the name "Holophane," which has such an excellent reputation throughout the country for quality of both goods and service. The full name of organization will hereafter be "Holophane Works of General Electric Company," instead of "Nelite Works of General Electric Company." This change, however, will not affect the different brands of trade nomes which the organization controls, such as Fostoria Products, Iris Glassware, Holophane Reflectors, Holophane-D'Olier Steel Reflectors, etc., which will all retain their present names.

PASS AND SEYMOUR, INC., of Solvay, N. Y., has issued folder No. 750, showing an interchangeable line of sockets from which 24 complete units can be assembled with 15 different parts. The folder is arranged so as to show graphically how the combinations are made. The line is known as "Presto." Further information will be sent to those interested upon application to the company.

THE ENGBERG'S ELECTRIC AND MECHANICAL WORKS is about to place on the market some small alternators, direct connected to vertical type steam engines. These are being built in small sizes, 24, 35 and 50 K-W capacities. The alternators are especially adapted to operate with Engberg engines, making a very complete plant for small isolated work. There are several makes on the market in the direct current, but this company claims to be the first to put on the market these sets for A. C. service.

THE JOSEPH DIXON CRUCIBLE CO., at the regular monthly meeting of the Board of Directors of the Joseph Dixon Crucible Co., held Monday, October 21st, the following changes in the officers and board of directors were made on account of the death of Vice-President William H. Corbin. Mr. George E. Long, former treasurer, was elected vice-president to succeed Mr. Corbin; Mr. J. H. Schermerhorn, former assistant secretary and assistant treasurer, was elected to membership in the board of directors and treasurer of the company. Mr. Albert Norris was elected to the office of assistant secretary and assistant treasurer.

THE CROCKER-WHEELER COMPANY has recently installed two 25 cycle, 4,500 KVA, three phase, core type butt joint water cooled transformers at the Superior Transformer Station of the Great Northern Power Company. These transformers were put to a sudden and severe test just a few hours after they were ready to be put into regular service. On one of the towers of the transmission line running to the Duluth Transformer Station which is tied in with the Superior Station, the six insulators were shot to pieces by rifle bullets, evidently with malicious intent, thereby putting out of service the transformers in this station. As this occurred just at the beginning of the peak load period the two Crocker-Wheeler transformers at Superior had to carry upward of 6,000 KW a piece until the damaged lines had been repaired and normal service restored.

THE LUX MANUFACTURING CO., 50-54 Grove street, New York City, is manufacturing a tungsten lamp known as the flexible-filament. This lamp is said to have all of the rugged features of the carbon lamp, the best points of the wire drawn lamp and other features which give it long ife and most economical in current. These lamps are made in all regular voltages and wattage. Further details can be secured from the company.

Electrical Devices Recently Approved.

The devices and materials appearing in this section each month, having recently been examined under the specifications given in the National Electrical Code and working in practice, are approved by the Underwriters Laboratories, Incorporated. The information in this section supplements the list published in April and October by the National Board of Fire Underwriters, and is for the convenience of engineers and electrical contractors who desire to ascertain the names of manufacturers up to date whose devices have been examined and approved.

THESE DEVICES SATISFY THE REQUIREMENTS OF THE SOUTHEASTERN UNDERWRITERS ASSOCIATION, AND HAVE BEEN APPROVED BY THE ELECTRICAL DEPARTMENT, A. M. SCHOEN, CHIEF ENGINEER.

FAIRBANKS-MORSE ELECTRICAL MFG. CO., Indianapolis, Ind. Type C, 10 to 100 H. P., 110 to 2,200 volts. Approved Nov. 1, 1912.

WAGNER ELECTRIC MFG. CO., St. Louis, Mo. Types known as 7-B-1, 7-B-1, 8-B-1, 9-8-1, 10-8-1. Approved October 11, 1912.

CABINETS.

BUTTE ENGINEERING & ELECTRIC CO., 683 Howard St., San Francisco, Cal. Cabinets of standard requirements. Approved Oct. 22, 1912.

CROUSE-HINDS CO., Syracuse, N. Y. Cabinets of standard requirements. Approved Oct. 27, 1912.

CUTTER COMPANY, GEORGE, South Bend, Ind. Cabinets of standard requirements. Approved Sept. 24, 1912.

ELECTRIC MFG. C., 926-940 La Fayette St., New Orleans, La. Cabinets of standard requirements. Approved Nov. 1, 1912.

JOHNSON, H. H., 277 Minna St., San Francisco, Cal. Cabinets of standard requirements. Approved Oct. 23, 1912.

NEWGARD & CO., HENRY, 947 Washington Blvd., Chicago, Ill. Cabinets of standard requirements. Approved Oct. 2, 1912.

D & W FUSE COMPANY, Providence, R. I. "D & W" fuse boxes. Cast-iron boxes containing 2 or 3-pole porcelain or slate cut-out bases. Waterproof style 0-600 A., 250 v.; 0-600 A., 600 v. Approved Oct. 11, 1912.

SCHMIDT ELECTRIC CO., A. R., 137 Oueida St., Milwaukee, Wis. Cabinets of standard requirements. Approved Oct. 24, 1912.

SUTTON COMPANY, JOHN S., 243 Minna St., San Francisco, Cal. Cabinets of standard requirements. Approved Nov. 9, 1912.

WESTERN ELECTRIC WORKS, 213 Sixth St., Portland, Oregon. Cabinets of standard requirements. Approved Oct. 14, 1912.

PANELBOARDS.

BUTTE ENGINEERING & ELECTRIC CO., 683-687 Howard St., San Francisco, Cal. Panelboards for 125, 125-250, and 250 volts. Approved Oct. 7, 1912.

CUTTER COMPANY, GEO., South Bend, Ind. Two and 3-wire, 125-250 and 250 volts. Approved Sept. 24, 1912.

PENN ELECTRIC & SUPPLY CO., Irwin, Pa. Two-wire boards for 125 or 250 volts; 3-wire for 125-250 volts with or without main line knife switches and cut-outs, with Edison plug or cartridge enclosed fuse cut-outs and knife switches in branch circuits. Approved Oct. 6, 1912.

PITTSBURGH ELECTRICAL & MACHINE WORKS, 1-2 Barker Place, Pittsburgh, Pa. 3-wire boards for 125-250 v., 2-wire boards for 125 and 250 v. Approved Oct. 9, 1912.

SUPERIOR ELECTRIC MFG. COMPANY, 2416-2418 University Ave., S. E., Minneapolis, Miss. "Pike" panelboards, 2 and 3-wire Approved Oct. 15, 1912.

SUTTON CO., JOHN G., 243 Minna St., San Francisco, Cal. Panelboards of standard requirements. Approved Nov. 7, 1912.

WESTERN ELECTRIC WORKS, 213 Sixth St., Portland, Oregon. Two and 3-wire, 125 and 250 volts. Approved Oct. 15, 1912.

FIXTURE WIRE—RUBBER COVERED.

The fixture wire manufactured by the following companies has been found in accordance with N. E. Code 1911, and approved Oct. 1, 1912: AMERICAN ELECTRICAL WORKS, Providence, R. I.; BISHOP GUTTA-PERCHA CO., 420-430 E. 25th St., New York; CRESCENT INSULATED WIRE AND CABLE CO., Trenton, N. J.; GENERAL ELECTRIC COMPANY, Schenectady, N. Y.; HAZARD MFG. CO., Wilkes-Barre, Pa.; INDIANA RUBBER AND INSULATED WIRE CO., Jonesboro, Ind.; KERITE INSULATED WIRE AND CABLE CO., 30 Church St., New York; MARION INSULATED WIRE AND RUBBER CO., Marion, Ind.; NATIONAL INDIA RUBBER CO., Briston, R. I.; NEW YORK INSULATED WIRE CO., 114 Liberty St., New York; OKONITE COMPANY, 253 Broadway, New York; ROME WIRE COMPANY, Rome, N. Y.; STANDARD UNDERGROUND CABLE CO., Westinghouse Bldg., Pittsburgh, Pa.; WATERBURY COMPANY, 80 South St., New York.

EACH ONE
OF THE TWO HUNDRED
TYPES OF

BROOKFIELD

INSULATORS

is the best insulator of its kind, YOU—or anybody can buy. That is why they are used for High and Low Voltage line construction—**Everywhere.**

Brookfield Glass Company
2 Rector Street
NEW YORK

WE SHALL BE GLAD TO RECEIVE YOUR REQUEST FOR PRICES, OR CATALOGUE.

WURDACK

Safety Cabinet

Designed especially to give residences, flats and apartment houses the same effective protection afforded larger installations by the use of panel-board distribution.

The Wurdack Safety Cabinet consists of a small special cabinet contained in a sheet iron fireproof cabinet with space provided for the installation of the current measuring meter in this cabinet. The upper half contains the meter, the lower half has a door covering the main fuses which may be sealed thus preventing tampering with fuses by unauthorized persons. A door over branch fuses is held by a catch, making it accessible to anyone. The cabinet is furnished in black enamel and is provided with a sufficient number of knockouts in the box to permit necessary connections with either ¼ inch loom or ½ inch pipe on branch circuits and ¾ inch pipe on entrance.

Send name and address for Bulletins

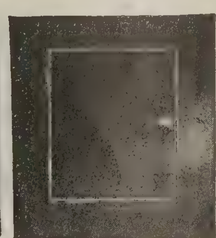
WM. WURDACK ELECTRIC MANUFACTURING CO.

Manufacturers of Switchboards, Panel-Boards, Cabinets, etc.

ST. LOUIS, MO.

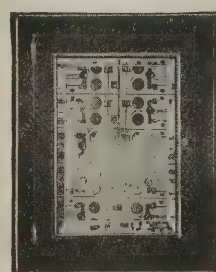
Bushing for all Knockouts

Type A—The usual box dust tight cover

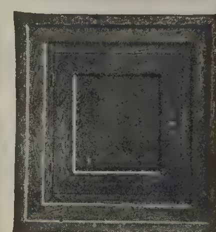


Type P—A cheap box with a door and Trim

Type C—A better one. beaded and paneled



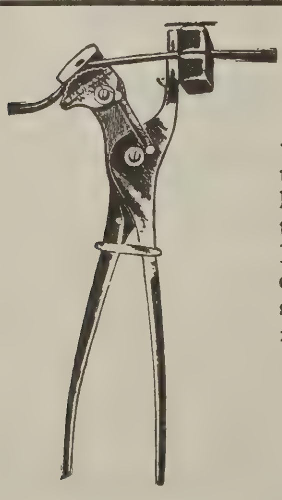
Type G—With a beveled plate glass panel in door.



Type SW—Steel with a natural oak, mahogany or walnut finish

COLUMBIA QUALITY STEEL CABINETS *The most complete assortment of stock sizes and styles. LOWER PRICED. GET ACQUAINTED NOW. WRITE..*

COLUMBIA, 226 E. 144 St., NEW YORK.



Wire Stretcher

For No. 8 Wire and smaller where cleats or split knobs are used. It rests against the insulator and holds the slack until the insulator takes the strain. Price, each, $2.50; less 25 per cent to the trade. We will send one only post-paid upon receipt of $2.00.

Socket Pull

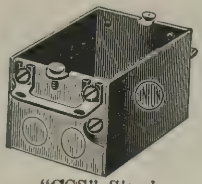
Slides on the key of an ordinary socket and converts it into a PULL SOCKET.

Alternate pulls turn the light on and off.

Made in all standard finishes. Send $1.75 for trial dozen postpaid.

THE A. E. RITTENHOUSE COMPANY

SCRANTON, PENNSYLVANIA.



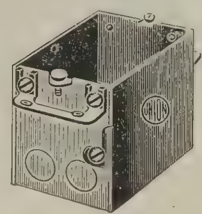
"CCS" Single
2 inches deep.

"UNION" Sectional Switch Boxes

Patented April 2, 1907—March 1, 1910—Feb. 13, 1912

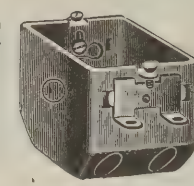
Have Reversible and Sliding ears adapted to plastered or unplastered walls.

The Type "C" Ear illustrated has an adjustment from 1-32 to 3-4 of an inch.

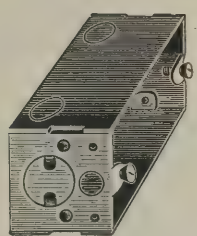


"CC" Single
2½ inches deep

Takes all makes of Switches and Receptacles made in depths ranging from *2 to 3½ inches*

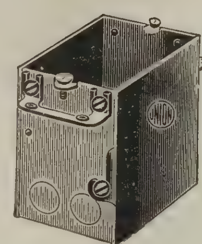


No. 190
Solid Drawn Box
2 inches deep



No. 170 1⅞ inches deep

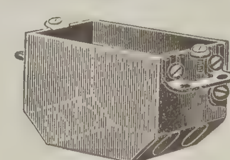
The most economical Box on the market. Being Sectional you can remove the side and insert spacers at little or no cost. You can't do this with one-piece Boxes.



"AA" Single
3 inches deep

The Box the Workmen Demand.

Write for Complete Box Catalog



"DD" Single
2 inches deep

Chicago Fuse Mfg. Company,

Chicago **New York**

HARNEY OF CHICAGO

has an unique

NEW BUSINESS AND PUBLICITY

plan of unusual merit

FOR CENTRAL STATIONS

which your company can adopt

WITHOUT ONE CENT OF COST

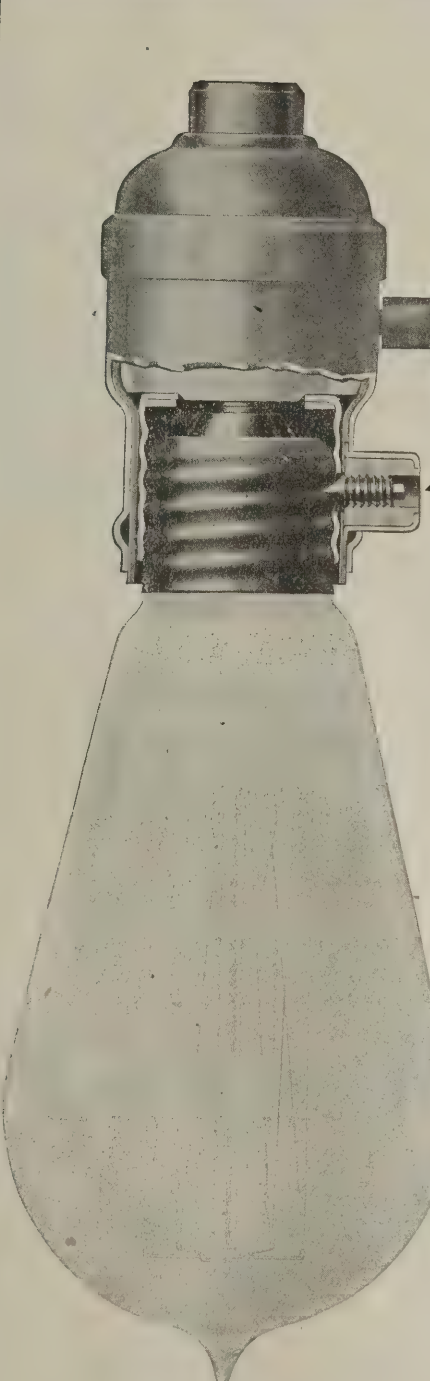
The plan is novel, dignified, effective, will not interfere with any other campaign you may have, and besides boosting your business will make for the greater good-will of your patrons—and all without cost to your company.

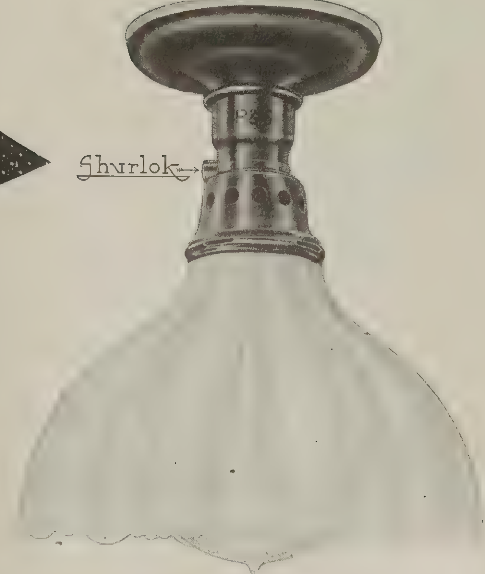
It has been approved by Central Station Presidents, Managers, Superintendents, Contract and Commercial Agents, Advertising and Publicity Managers, etc., and endorsed and adopted by leading Central Stations throughout the United States.

Your company can, and should, take advantage of it. Write today for particulars to

J. A. HARNEY, 54 W. Lake St., CHICAGO, ILL.

KNOW THE SAVING





Have you any customers who hesitate to install Mazda or Tungsten lamps due to the danger of theft?

If so, you can assure them that the lamps will not be stolen if they put these lamps in P & S Shurlok—the socket that locks.

The Shurlok makes it possible to use Mazda and Tungsten lamps in every place, to use them effectively and economically. Theft is absolutely prevented and troublesome guards done away with.

HOW IT WORKS

The illustration herewith will demonstrate how simple the device is and yet how difficult it would be to unlock the socket without the proper key.

The lamp is shown locked in place. The head of the set screw locking the lamp in place is of a peculiar triangular shape, deeply recessed, so that it cannot be reached with tools. The key is sold separately from the socket and is only sold to those properly entitled to possess one.

The distribution of the key is safe-guarded in every possible way. There are no other keys on the market just like this, and it is not possible to operate the lock with an old style watch key.

Pass & Seymour, Inc.

MAIN OFFICE AND WORKS

Solvay, New York, U. S. A.

NEW YORK CITY	SAN FRANCISCO	CHICAGO
178 Fulton Street	Rialto Bldg.	700 West Jackson

DENVER Sales Agents—B. K. SWEENEY ELECTRICAL CO.

PASS & SEYMOUR, Inc., SOLVAY, NEW YORK
Send us sample of Shurlok Locking Socket without expense to us. Send your catalogue, too.
Name ....
Address ....
City ....
State ....
Coupon No. 43.

The WESTON SYNCHROSCOPE

Constitutes a very simple and absolutely *perfect solution* of problems involved in coupling alternating-current machines in parallel without danger or sensible disturbance of circuit conditions.

The indications are infallible.
There is only one object to observe.

The movement of the pointer is smooth and certain; it inspires confidence.

It indicates exact synchronism within 1 deg. of true phase coincidence over a wide range of frequency and voltage.

Send for catalog giving full *description of this unique nistrument* and also our full line of A. C. and D. C. instruments for Switchboard, Portable and Laboratory Work.

Demonstrations of the operative characteristics of these remarkable instruments may be observed in our New York Office and also in the offices of Selling Representatives n Philadelphia, Chicago, San Francisco and Toronto.

Weston Electrical Instrument Company, OFFICE & WORKS, Newark, N. J

New York, 114 Liberty St.
Chicago, 1504 Monadnock Block.
Boston, 176 Federal St.
Philadelphia, 342 Mint Arcade.
Birmingham, Brown Marx Bld.
St. Louis, 915 Olive St.
Denver, 231 15th St.
San Francisco, 682 Mission St.
New Haven, 29 College St.
Cleveland, 1522 Prospect Ave.
Detroit, 44 Buhl Block.
Paris, 12 Rue St. Georges.
Berlin, Genest Str. 5, Schoenberg.
London, Audrey House, Ely Pl., Holborn.
Tronto, 76 Bay St.
Montreal, Winnipeg, Vancouver, Calgary } The Northern Electric & Manufacturing Company

OKONITE

TRADE MARK REG. U.S. PAT. OFFICE.

The STANDARD for RUBBER INSULATION

Whether purchased in the open market, from our agents, or direct from us *Okonite* Insulated Wires and Cables never fail to meet, unconditionally, the most the severest requirements of *any* service.
OKONITE is made in but one grade—*the BEST* searching specifications and consequently

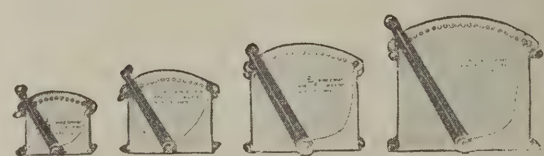
The Okonite Company

253 Broadway, NEW YORK

Central Electric Company, Chicago, Ill.
General Western Agents
E. D. Lawrence Electric Co., Cincinnati, O.
Novelty Electric Co., Phila, Pa.
Pettingell-Andrews Co., Boston

WARD LEONARD

Small Theatre Dimmers For Halls and Lodges



RESISTANCE IN THE FORM OF ENAMELED PLATES
100 TO 150 VOLTS

No. 16 cp. Lights Controlled.	List Price	Dimensions in Inches
2	$2.50	5½x5½
4	2.50	5½x5½
8	2.75	7 x7
12	2.75	7 x7
15	3.50	9 x9
20	3.50	9 x9
25	4.25	11 x11
30	4.25	11 x11
40	7.75	14 x14
50	7.75	14 x14

Can be easily mounted in enclosing cases. More dimmers of this kind are in use than all other kinds combined.

WARD LEONARD ELEC. CO., Bronxville, N. Y.

ALPHABETICAL INDEX TO ADVERTISERS

POSITIONS WANTED

The rate for "Positions Wanted" and "Help Wanted" advertisements of 40 words or less is one dollar an insertion; additional words, two cents each, payable in advance. Remittances and copy should reach this office not later than the twentieth of the month.

Replies may be sent in care of SOUTHERN ELECTRICIAN, Atlanta, Ga.

WANTED—A competent white line foreman who is accustomed to handling negro linemen. In answering, state age, experience and salary expected. Also give reference. Address "Light," care Southern Electrician.

POSITION WANTED—I have had five years experience superintending substation with 44,000 line volts. Also handling 5 high tension transmission lines. Two years experience city construction work. One year operating D. C. railway station. If you have anything to offer me address "E," Southern Electrician.

POSITION WANTED—As chief electrician of large industral plant. Graduate electrical engineer. Eleven years experieuce in electrical department of steel and cement mills, copper concentrator and smelter. Both alternating and direct motors, lighting, etc. Organizer—single—sober—references. Address "Columbia," Southern Elecrician.

YOUNG MAN now employed wishes position with some power company as superintendent of lines. Has had previous experience in handling of men and construction. Can furnish best of references. Answer "Power," care Southern Electrician.

OLD ESTABLISHED BUSINESS— for sale doing wiring, contracting, A. C. & D. C. Motor repairing, selling supplies, etc. Shop full of work, and future outlook very bright. Excellent reason for selling. Price $2,500.00 cash, or payments accepted from right party. F. J. Lamb, 162 Baldwin Ave., Detroit, Mich.

For Sale

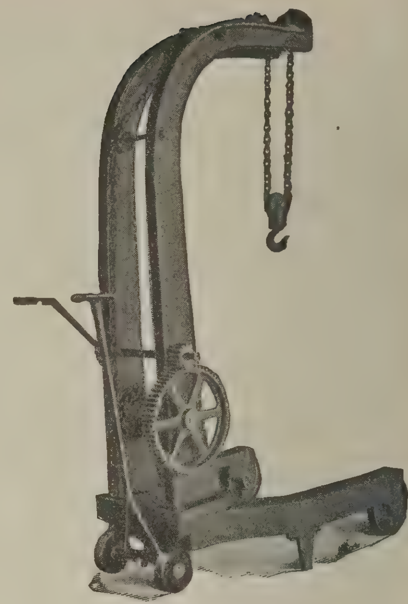
4 TRANSFORMERS

built by American Transformer Co., for 110 volts, 60 cycles, just like new, $22 each.

COSMOS ELECTRIC CO.

134 Liberty St., New York

FOR SALE—LIGHT, WATER, ICE and BOTTLING PLANT (all in one building). In growing town of two thousand, near Memphis. Also supply adjoining town of 1,500 with light. Equipment in good shape, just finishing standard water works. Physical value about Fifty Thousand Dollars. Gross annual income approximately Twelve Thousand Dollars, increasing fast. Will sell to right parties, with competent manager for one-fourth cash, balance bonds. Address C. D. M. Greer, care Greer Coal & Mining Co., Memphis, Tenn.



THIS CRANE

$57.00

DIMENSIONS

Total height 5 ft. 8 in.; Lift 4 ft. 6 in.; Overhang 2 ft. 3 in.; Width of bed outside 2 ft. 5 in.; inside 1 ft. 10 in.; Length of bed 2 ft. 11 in.; Height of bed 9 in. Capacity 3000 lbs. Weight 600 lbs.

Write today.

Machinery Sales Co., ***Cleveland, O.***

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LUX MFG. CO. N.Y.C.

TRADE **FLEXILUX** MARK

FLEXIBLE FILAMENT

TUNGSTEN LAMP

FOR ALL CONDITIONS

TOUGH, DURABLE AND EFFICIENT

LUX MANUFACTURING COMPANY

50-52-54 GROVE STREET

TEL. 2151-2152 SPRING NEW YORK CITY

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Klein & Sons, Mathias.

DIRECTORY OF CONSULTING ENGINEERS ARCHITECTS and CONTRACTORS

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twenty years old are still in service. "PACKARD" insures

Long Life

Safety

Low Losses

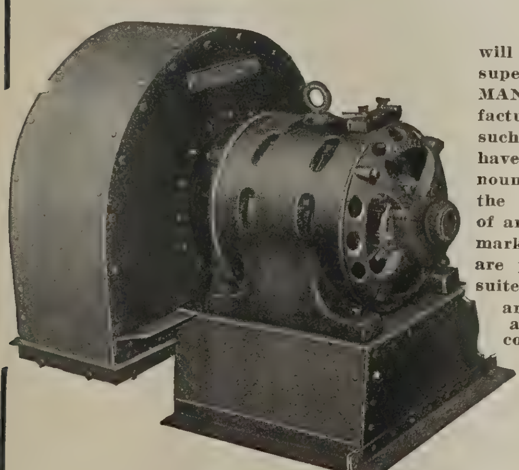
If you use transformers, it is up to you to get acquainted with PACKARD quality. Let us tell you why. It means money in your pocket and another Packard enthusiast if you will take advantage of our trial offer.

THE PACKARD ELECTRIC CO., 319 Dana Avenue, WARREN, OHIO

For the Operation of Heating and Ventilating Fans, Organ Blowers, etc.

Where Quiet Operation is Necessary

Century Single Phase Motors

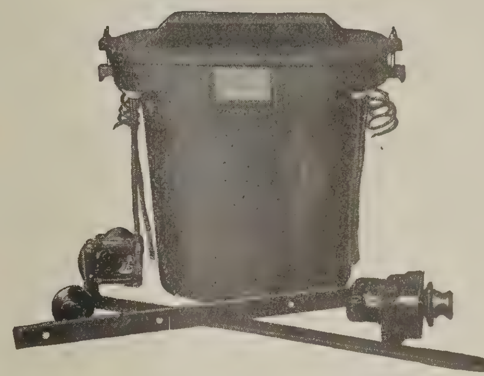


will be found superior. MANY manufacturers of such apparatus have pronounced them the most quiet of any on the market. They are particularly suited to remote and automatic control.

CENTURY ELECTRIC CO.,

19th and Olive Sts., St. Louis, Mo.

PEERLESS TRANSFORMERS



Mr. Central Station Manager

Does it appeal to you to KNOW that every transformer on your line is protected by an absolute two year guarantee?

*** * * * READ THIS * * * ***

We guarantee that all PEERLESS TRANSFORMERS will conform to or excel the published specifications of losses, regulations, efficiencies, and temperature rise.

We also guarantee PEERLESS TRANSFORMERS for a period of two years from date of shipment and will repair or replace free of charge at the factory any transformer rendered inoperative through inherent mechanical or electrical defects.

We will repair or replace at the factory during this period any transformer damaged by lightning, provided it is protected by approved lightning arrester within 500 feet of the transformer.

The Enterprise Electric Co.

WARREN, OHIO

"Transformers of all kinds for all purposes."

THORDARSON Toy Transformers

Will Be in Big Demand

Holiday season is fast approaching and retailers will be kept busy supplying the ever-increasing demand for THORDARSON Toy Transformers. Hence it will pay every jobber to

Stock Up Now!

THORDARSON Toy Transformers are veritable power plants in miniature. Always satisfactory. Operate bells, buzzers, toys, Rhumkorff and other induction coils. Prices $5, $7, $8 and $10, according to type of transformer. Alternating current only.

At all electrical jobbers

Write for Descriptive Folders

Thordarson Electric Mfg. Co.
507 So. Jefferson St., Chicago

MORE

AMERICAN SIGN TRANSFORMERS

Used on
New York's

GREAT WHITE WAY

than any other make

Send for Bulletin 534-A

American Transformer Co.
NEWARK, N. J.

DUNCAN TRANSFORMERS

are the best ever made, and the fact of their quality being so high and the price so moderate is due to the small overhead expense incurred in their manufacture. The company has no salaried officers to support, therefore the purchaser does not have to pay for this uncalled for luxury, and gets more value for his money than is otherwise possible.

DUNCAN
A. C. & D. C. METERS

are preeminently known for their accuracy, excellent workmanship, high torque, and all around dependability. They are extensively used in every country on the globe, and during one month of last year, there were more of them shipped into three of the Central States than all of our competitors combined during the same period.

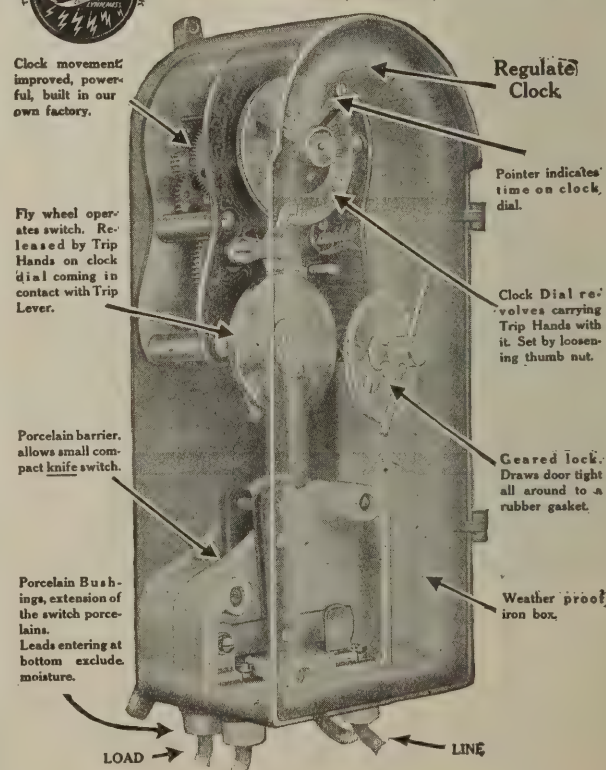
If in doubt about Duncan Meters--ask the man who uses them.

DUNCAN ELECTRIC MANUFACTURING CO.
LAFAYETTE, INDIANA.

REG.U.S. PAT.OFF. TRADE MARK

Campbell Time Switch the Best

(PATENTED)



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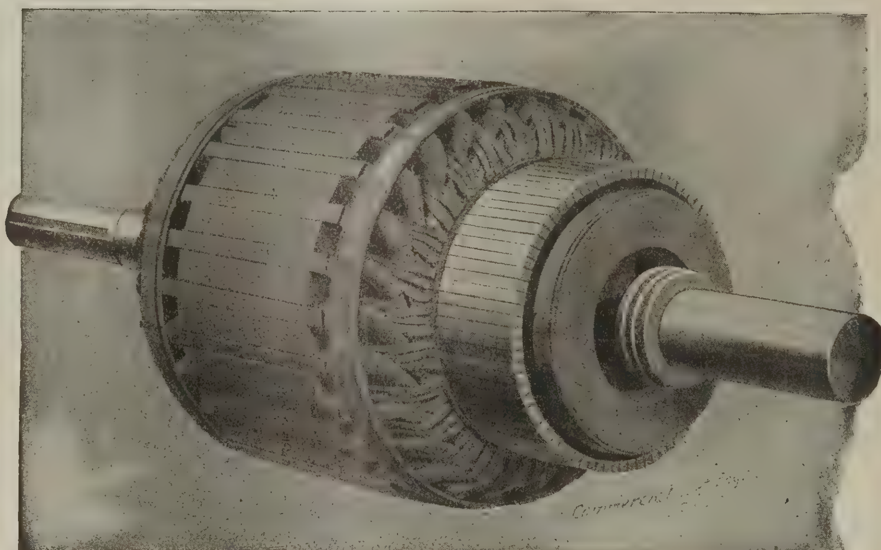
Campbell Electric Co., Lynn, Mass.



A Concentrated Output Means a Quality Output

Why do you suppose we have everlastingly stuck to the manufacture of small and moderate size motors? Our engineers could design motors of 100, 500 or 1,000 H. P., and other lines of electrical apparatus.

But 15 years ago we realized that the biggest field for motor application was in capacities of 1/8 to 45 H. P. We also knew that to make these sizes efficient and reliable required the best engineering skill and thoroughness.

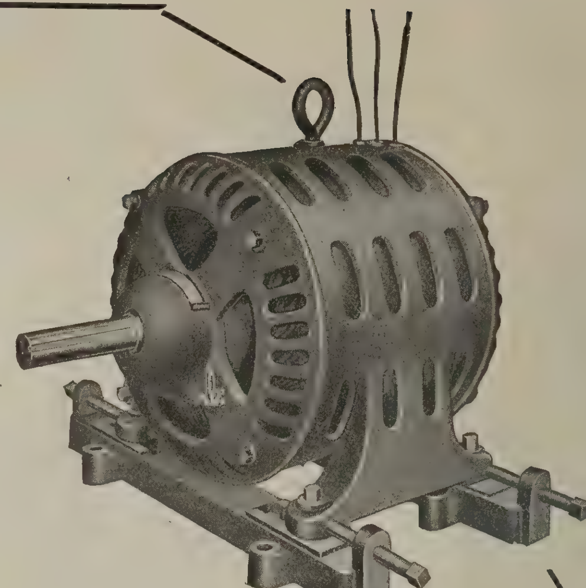
WATSON MOTORS

A. C. UP TO 45 H. P.; D. C. UP TO 15 H. P.

have made good because every feature of design and construction has been perfected, even to the smallest detail.

Why not stock a line of Watson D. C. and A. C. (single and polyphase) motors now?

For the smallest stock you will have the widest range of applications.



WATSON VENTILATING FANS are needed in dance halls, theaters, billard and pool rooms, moving picture shows, schools, public halls, factories, etc.

Are you getting your share of this business? Booklet on Watson Ventilating Fans, free on request.

Do You Need a High Speed Motor?

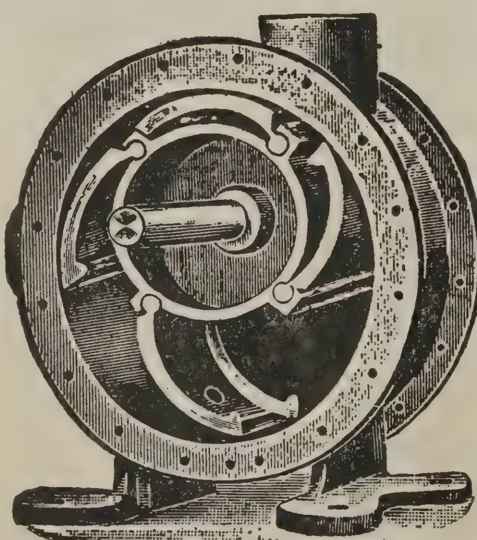
Some applications require extra speed motors. If you want quotations on 3600 R. P. M. A. C. motors write us today. Watson extra high speed motors have perfectly balanced rotors, proven so by service.

Mechanical Appliance Co.

Milwaukee

LEIMAN BROS. POSITIVE

BLOWERS AND VACUUM PUMPS



One oz. to 10 lbs. pressure; 1 to 20 inches Vacuum; 2 to 338 cubic feet per minute, used with oil and gas appliances, agitating, VACUUM CLEANING, Etc.

Catalog No. 109—Blowers
Catalog No. 110—Vacuum

LEIMAN BROS.

62 AT John St., New York

Electricians' Pocket Screw Driver

No. 560—The handle is covered with hard rubber for insulation from electrical currents, and is nicely ribbed so as to insure a firm grip when using the tool. It has four blades of different widths, any one of which may quickly be taken from the telescope handle and inserted in the end, where it is automatically locked and firmly held for use Any or all of the blades are carried in the handle, where by a spring pressure they are held from rattling when carried in the pocket, or from being lost when the cap is off. While the cap may be readily pulled off or put on it is rigidly held from turning and frictionally held from coming off, with no screws to bind or bother.

The smaller blades may be used to make holes in wood for screws as well as to drive them home.

The widths of the blades are 3-32 in., 5-32 in., 1-4 in. and 3-8 in.

Price, complete,	$1.50
Extra Blades, each,	.10

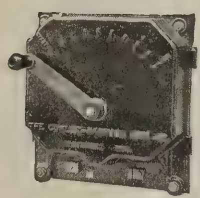
Ask for Free Catalogue No. 189 of Fine Mechanical Tools.

THE L. S. STARRETT Co.

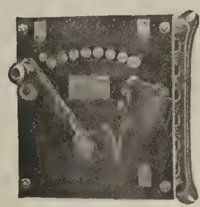
ATHOL, MASS., U. S. A.

CUTLER-HAMMER

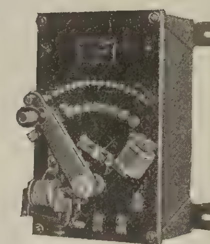
Regulator for Alternating Current Motor. Bulletin 9320.



Enclosed Motor Starter for Dusty Location. Bulletin 2190.



D. C. Speed Regulator for Fans, etc. Bulletin 3110.



Combined Starting and Regulating Rheostat. Bulletin 2240.

Engineering Advice and Service

A motor starter, regulator or one of the simpler types of controllers might be built to resemble a Cutler-Hammer product. The interior construction (at least the parts not protected by patents) might be imitated or copied.

But there is no copying of Cutler-Hammer experience and enginering service.

Cutler-Hammer engineers have developed, step by step, all of the apparatus comprising the most extensive line of controlling devices on the market, including the smallest types of starters and regulators, and the largest steel mill controllers. We know the reason for each feature and detail of a Cutler-Hammer controller and know what changes or additions are needed to meet various out-of-the-ordinary requirements.

When you get a Cutler-Hammer controller you do not get simply so much slate, brass and copper, but you get EXPERIENCE. Relieve yourself of much work and worry—just

Put Your Control Problems Up to

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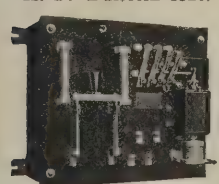
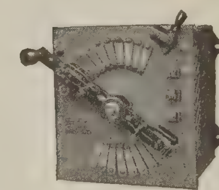
Bulletins on any class of controllers sent promptly on request.

A. C. Starter. Drum Type. Cover Removed. Bulletin 9135.

6-in. Speed Regulator for motors 1/20 to 1/6 H. P. Bulletin 8520.



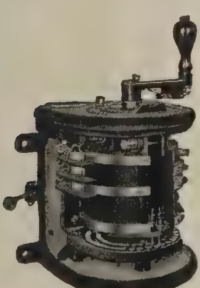
Automatic Motor Starter for Vacuum Cleaners, Pumps, etc. Bulletin 6100.



A. C. Starter for Slip Ring Motors of Moderate Capacities. Bulletin 9125.

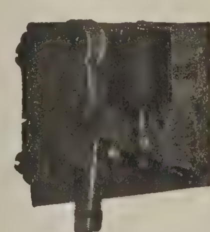
D. C. Starter with Knife Switch and Fuses. Bulletin 2150.

Gauge Type Pressure Regulator. Bulletin 6760.

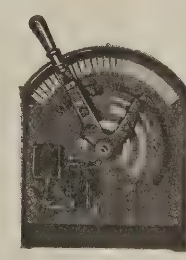


Machine Tool Controller. Bulletin 5220.

D. C. Motor Starting Rheostat. Bulletin 2110.



Automatic Motor Starter. Bulletin 6140.



Printing Press Controller, Carpenter Type. Bulletin 4100. (Cover removed.)

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Your Christmas Stock

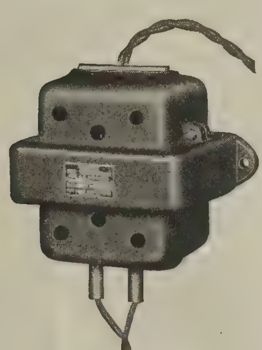
Should Include a Supply of Wayne Transformers

The demand for practical Christmas gifts grows greater each year and electrically operated devices and toys are now very popular.

It is essential that the little transformers used for stepping down the voltage for such devices be especially reliable and you can be certain when selling

Fort Wayne Miniature Transformers

that they are of the same high quality as our well known large sized line and are practically fool and danger proof.



Wayne Toy Transformers are designed to operate small motors, railways and other electrical toys. By using the various combinations of terminals 3-6-11-14-17 and 20 volts can be secured. They are substantially built for the hard service generally given them by children and cannot be injured by short circuiting.

They are built in 125 and 60 watt sizes and are especially adapted for use with Christmas tree lighting outfits, etc.

The Wayne Bell Transformer is made in three different sizes for use in operating various kinds of door bells, buzzers, annunciators, burglar alarm systems, etc. Combinations of 4-8 and 12 volts are given by the secondary terminals.

They take the place of the unreliable, unsightly dry batteries and give a dependable service with no danger of burn-outs and with hardly any expense.

These transformers cost a little more than the rosin filled tin can type, but they are worth the difference. The core and coils are vacuum treated and they are in every way built to meet the demand for a safe, substantial transformer.

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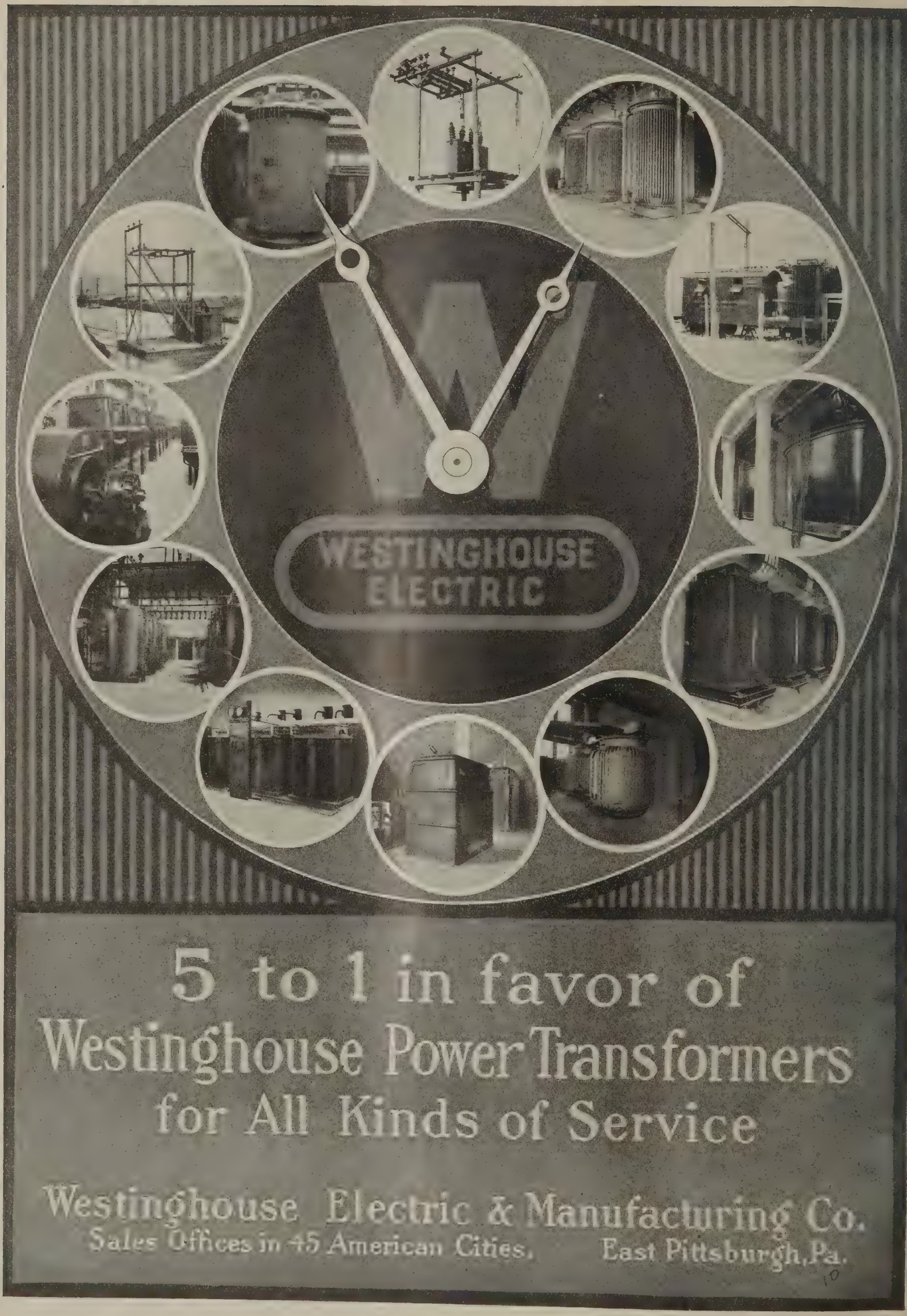
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